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POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

Vol. 29 Index to Advertisers and Classified Index Following Readng Matter No. 3.

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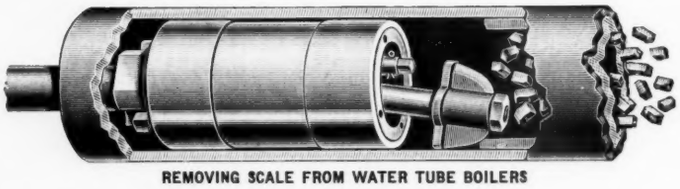
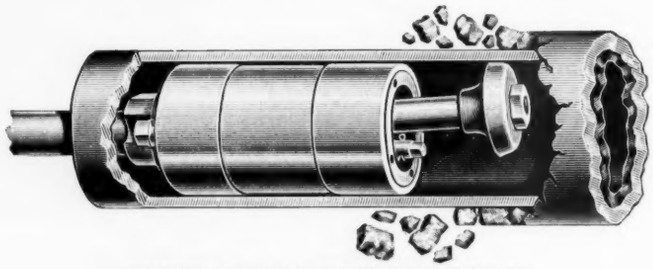


REMOVING SCALE FROM WATER TUBE BOILERS



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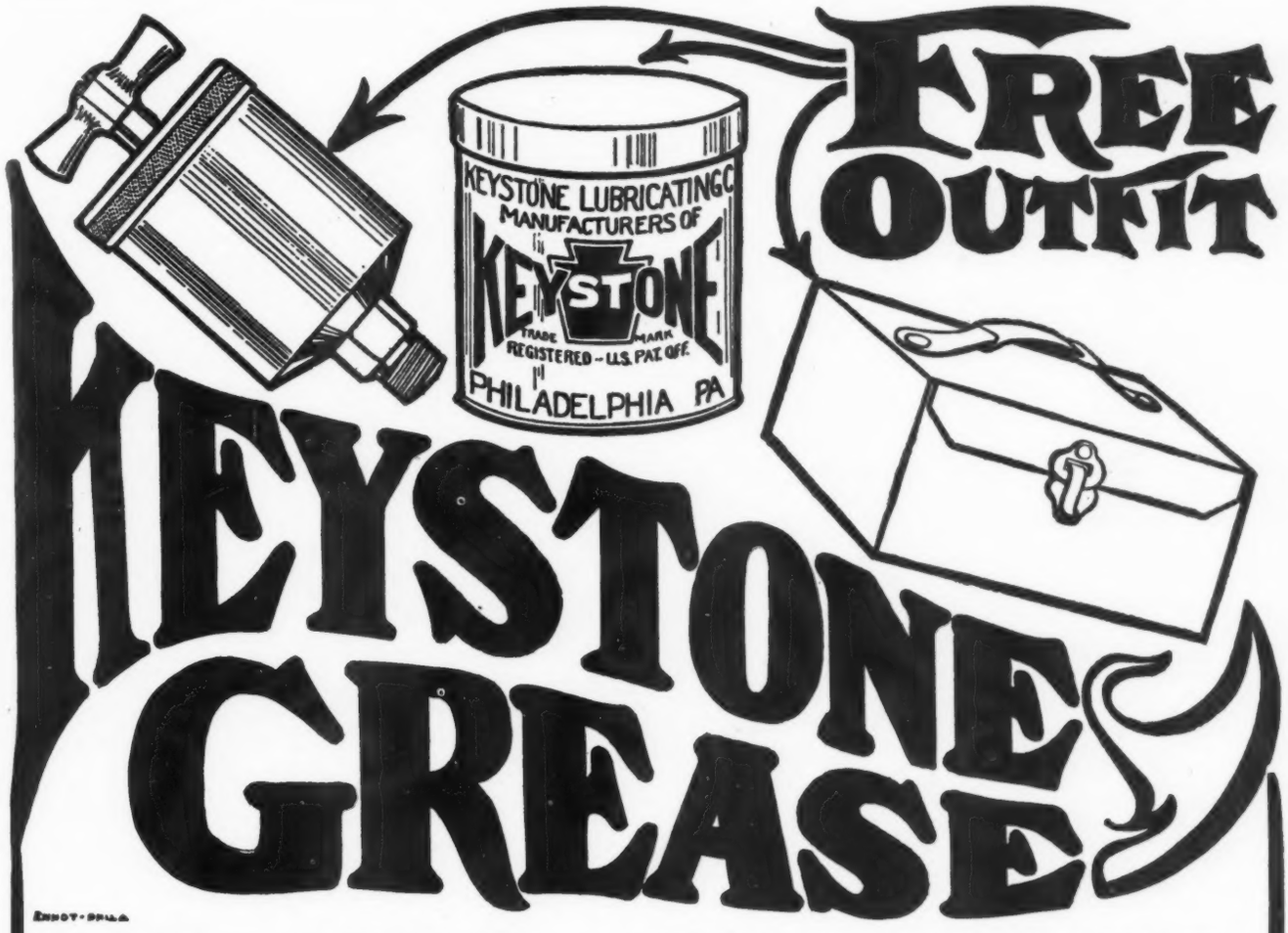

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July 7-08, Dept. B

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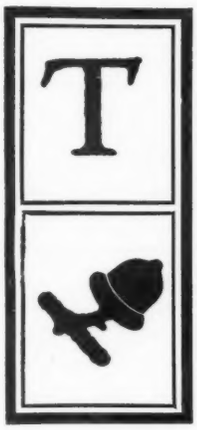

THERE is always one great pioneer and leader in the development of every important industry. Twenty years ago, the fact that great savings could be made in fuel consumption and that boilers and boiler tubes could be made to last much longer, but for the detrimental action of boiler feed waters, interested some young chemists in Chicago in the possibility of surmounting this difficulty by making careful analytical study of different classes of waters, and finding scientific reagents for the elements that produced the trouble.

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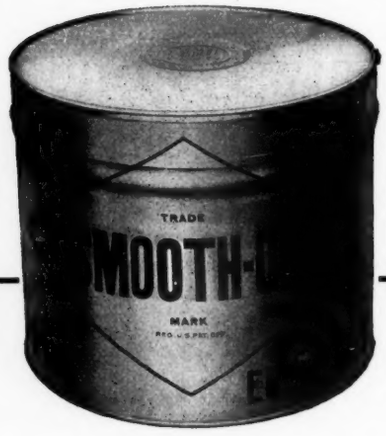

Why SMOOTH=ON Is Invaluable In The Power Plant

Read These Two Letters

Jersey City, April 26, 1901.

To Whom It May Concern:

We have used Smooth-On Iron Cement for leaks and fractures on water jackets of gas engines with satisfactory results. We find it an economical way of making a durable repair.

HUDSON COUNTY GAS CO.,
P. S. Young, Sec'y.

Department of Commerce and Labor.
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The Smooth-On Mfg. Co., Woods Hole, Mass., Aug. 4, 1903.
No. 572-574 Communipaw Ave.,
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Gentlemen:—In March of 1903 we bought of the Walworth Mfg. Co., 132 Federal St., Boston, twenty-five pounds of your Smooth-On Compound to repair a leaky boiler, on which boilermakers had worked and had only succeeded in stopping the leaks for a short time.

The boiler is of Scotch type and the leaks were around the ends of the furnaces. In applying the Compound I first cleaned the surface of the iron inside the boiler and then washed and let it stand 12 hours. Then I mixed a thick putty of Compound and pressed it well in the joint, let it stand 24 hours and it was a success. The boiler has been in use now for three months and is tight. I have also used the Compound for making pipe joints, and have found it excellent.

Very respectfully,
GEORGE E. DAVID,
Engineer and Machinist.
Woods Hole, Mass., Bureau of Fisheries Station.

Smooth-On gets its great value from the fact that it metallizes slowly and expands in the process, thus making perfectly tight joints that must stay tight.

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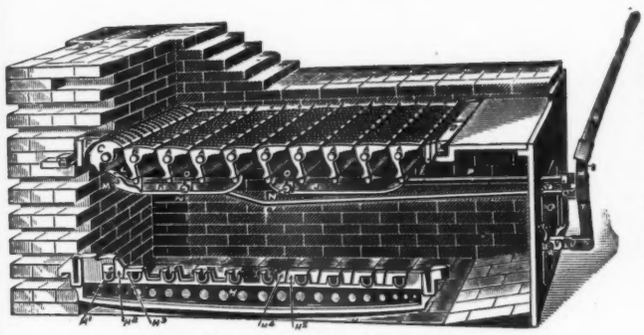

Plate No. 1 Normal Position of Grate.

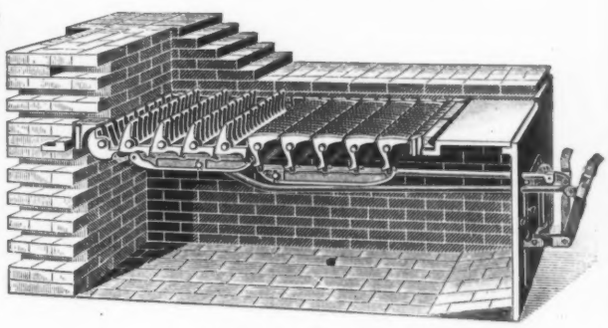

Plate No. 4. Divided Cut-Off.

McClave Grates and

Argand Blowers

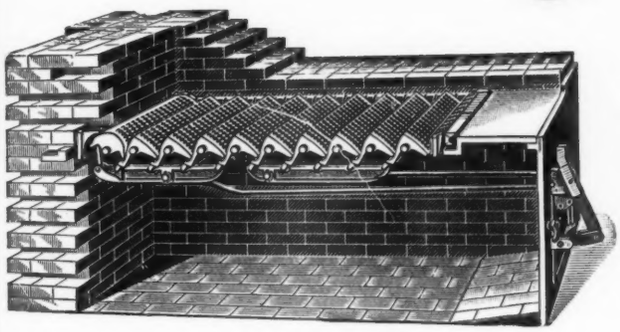

Plate No. 2. Shaking Movement.

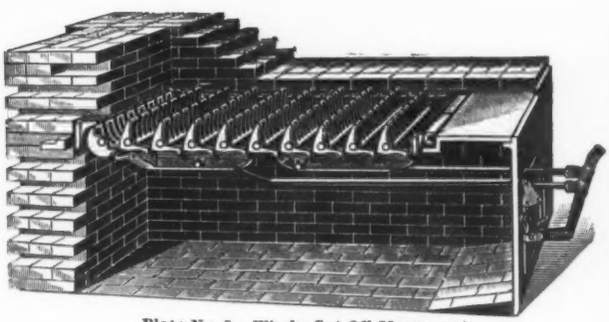

Plate No. 3. Whole Cut-Off Movement.

The grates furnish the most perfect beds for burning fuel of even the smallest sizes and are provided with cutting, shaking and dumping movements which insure clean even fires.

The blowers produce a forced draught between the uptake and the upper surface of the fire, thus causing the most complete combustion possible.

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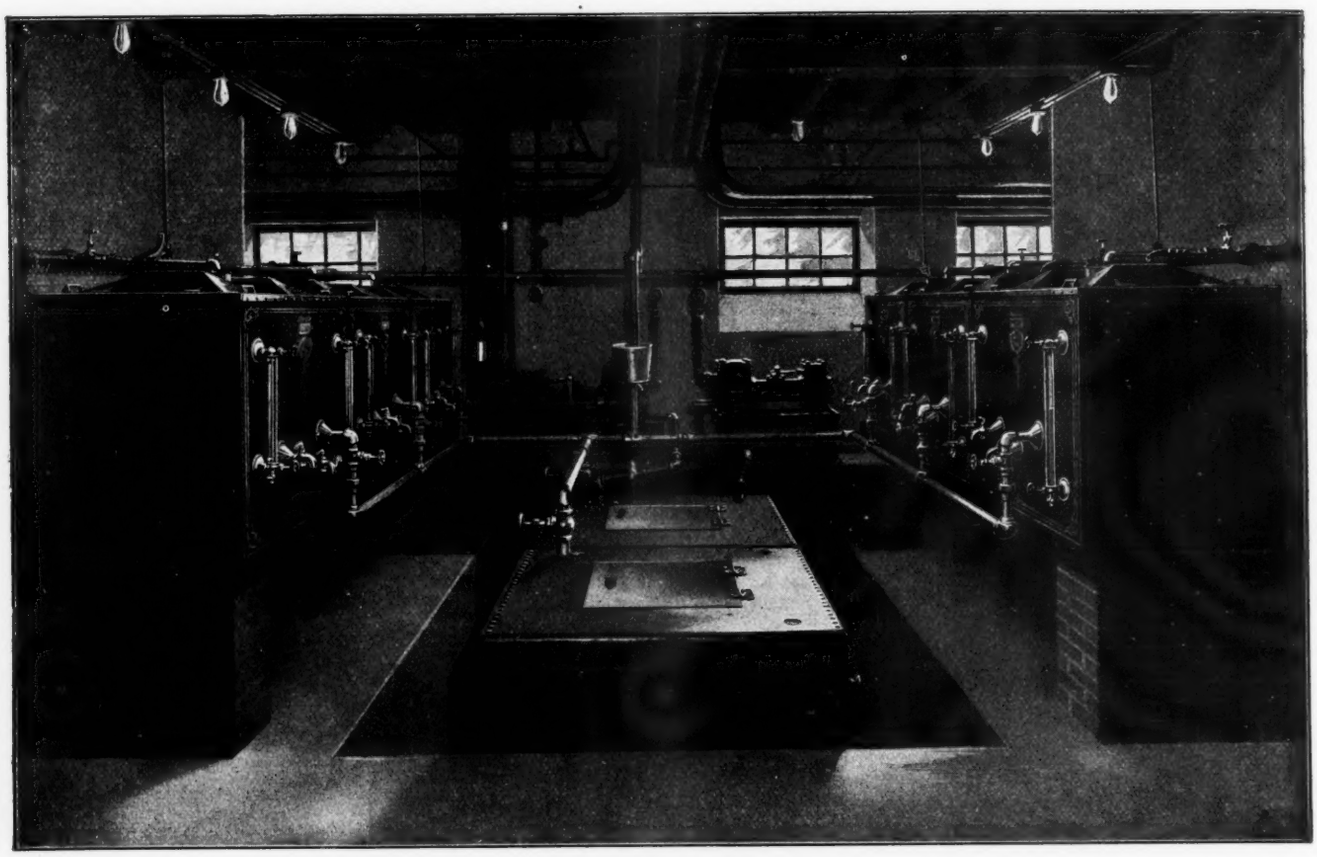

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Eight More "Units" For Philadelphia

The Philadelphia Rapid Transit Co., operating eight large modern power plants, after thoroughly inspecting and testing the many different filters on the market and carefully noting the advantages and disadvantages, selected and installed six "Units" to operate with an oiling system.

And while these filters are cleaning perfectly over 2,000 gallons of oil every 24 hours (we only guarantee 1,500), they can—if operated at their full capacity—very easily handle from 3,500 to 4,000 gallons.

We told you their first order was for 6; then an order for 4, and another one for 6, and now they have just placed *an additional order for* 8 *more*, making a total of 24 "*Units*" in all which we have furnished them. This ought to speak volumes to you.

Each "Unit" is 42 inches long, 3 feet high, and 28 inches wide and has a filtering capacity of from 200 to 250 gallons in 24 hours.

But the "Unit" does not need an oiling system, each one is complete in itself—one is just as effective as six—provided, of course, your plant requires only one. As the plant increases, additional "Units" can be installed. They are so constructed that any kind of filtering material may be used. They are guaranteed to clean and purify the thinnest and heaviest grades of lubricating oil.

We have a new 92-page catalog, the most handsome ever issued by any filtering concern; if you are connected with, or interested in power plants, or a manufacturing concern; you certainly should send for a copy as it fully describes our complete line of Oil Filters, Exhaust Heads and Ventilators.

THE BURT MFG. CO., 232 Main St., Akron, O., U.S.A.

Largest Manufacturers of Oil Filters in the World.

Power Plant of the Bryant Paper Company

Outline Description of the Steam Plant of One of the Largest Mills in Michigan, with a Summary of Coal Consumption

BY GEORGE H. CHANDLER

In the State of Michigan the manufacture of paper is so important an industry that to the city of Kalamazoo alone must be credited eight mills, nearly all of which manufacture book papers. The largest of these mills, and in fact the largest paper-manufacturing establishment in the State of Michigan, is the Bryant Paper Company, which operates three mills with a combined weekly capacity of from 600 to 900 tons of paper. These mills, which are numbered 1, 2 and 3, are practically all under one roof, and in addition there are the Superior Paper Mill and the Imperial Coating Mill, which are a part of the Bryant plant. All of the buildings are grouped closely together so that the plant is compact and conveniently arranged.

In the manufacture of paper a large number of costly paper machines and special machinery are required, and the driving of these various machines demands a large amount of power. In the present plant 20 engines and 21 boilers are installed, but it is not the purpose of the present article to go into detail and describe each of these, but simply to enumerate the machines installed and illustrate only a few of the engines and boilers.

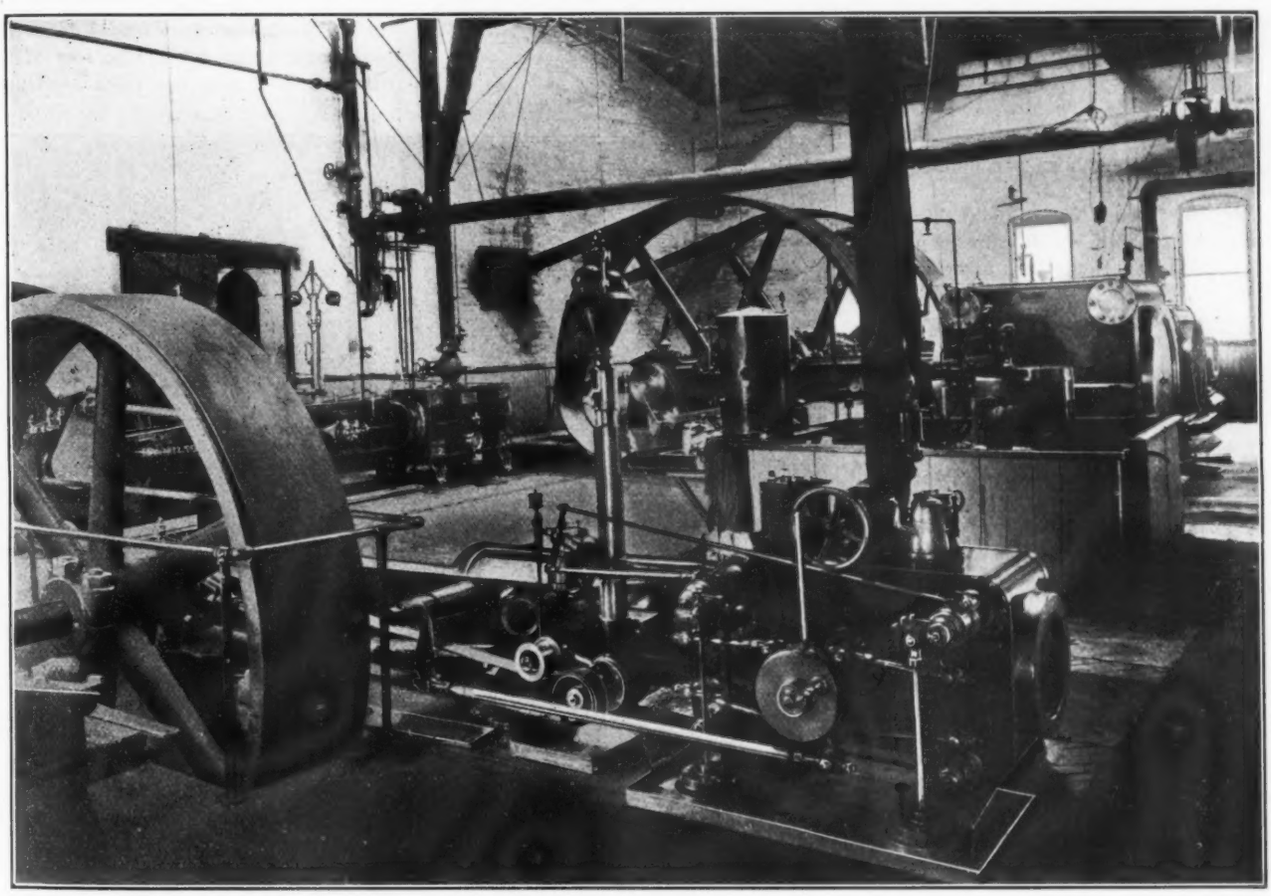


FIG. 1. ENGINE ROOM NO. 1

Plant Equipment

In engine room No. 1 there are four engine units, three of Nordberg design and one a Hamilton engine. The largest of the Nordberg engines is a triple-compound with cylinders 14½x27x40 inches and a stroke of 40 inches. This unit develops from 600 to 700 horse-power at a speed of 80 revolutions per minute and a steam pressure of 130 pounds per square inch at the engine. It is used to drive the beaters and washers and also as a general drive. The engine is shown in the background of Fig. 1, and in this view the two large fly-wheels will be noted. The wheels have 32-inch faces and are 16 feet in diameter.

The second Nordberg unit is a simple engine, with dimensions 12x28 inches, developing 104 horse-power at 90 revolutions per minute. The third engine of Nordberg design is a cross-compound with cylinders 16 and 28 inches in diameter and a 40-inch stroke. The engine is used to drive the calenders and develops 350 horse-power when revolving at 80 revolutions per minute. The Hamilton engine, which is 14x36 inches, has a speed of 90 revolutions per minute. It is set at right angles from the other machine

engine and transmits its power by means of miter shell-core gear wheels, developing from 98 to 120 horse-power as per requirements. In the way of auxiliaries these engines are provided with two Nordberg air pumps and condensers, and for fire protection one Laidlaw-Dunn-Gordon duplex pump, 18x10x12 inches, with a capacity of 1000 gallons per minute, has been installed.

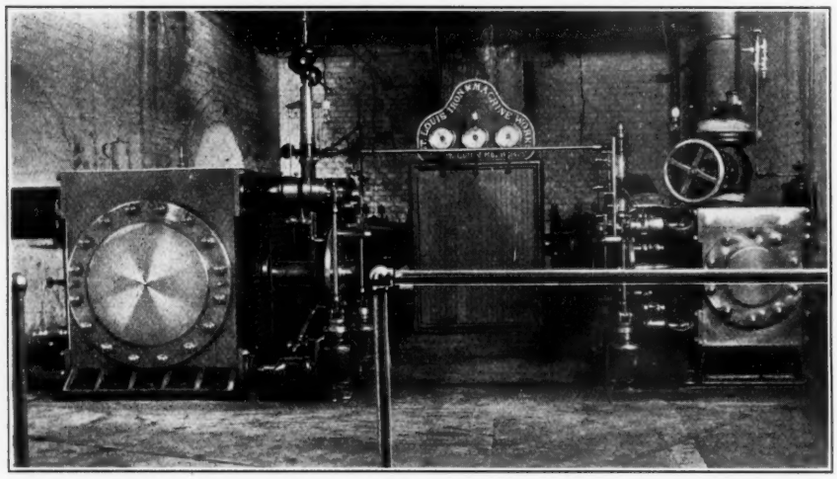


FIG. 2. CALENDER ENGINE IN MILL NO. 3

In engine rooms Nos. 2 and 3 there are five engines, all of which were manufactured by the St. Louis Iron and Machine Works, of St. Louis, Mo. Two are cross-compound units and the other three are simple engines, while all are of the heavy-duty type. Of the cross-compound engines the largest, which is 22x44x48 inches, develops 1000 horse-power when turning at a speed of 85 revolutions per minute. The other cross-compound develops 300 horse-power and is used to drive the calenders. It has cylinders 16x28x42 inches and a speed of 80 revolutions per minute.

Of the simple engines, there are two of the variable-speed type which drive the paper machines Nos. 4 and 5. The engines are 14½x36 inches and make all the way from 40 to 120 revolutions per minute. The other simple engine is 12x36 inches and has a constant speed of 90 revolutions per minute. This unit is used to drive the dynamo and wet end of the paper machines.

To generate steam for all these engine units, there are in boiler room No. 1 six water-tube boilers, two vertical and four horizontal boilers of Wood patent. Each boiler is rated at 200 horse-power and all were manufactured by Wickes Brothers, of Saginaw, Mich. The vertical boilers are equipped with Murphy furnaces and the Wood boilers are hand-fired.

For mills Nos. 2 and 3 seven Wickes vertical water-tube boilers have been installed. Three of these are rated at 200 horse-power and the remaining four at 300 horse-power. They are all equipped with Jones Under-feed stokers and employ forced draft in combination with the natural draft from two stacks, one of brick and the other of steel and both 150 feet high. For mill No. 1 there are also two chimneys, one of brick and one of steel. These, however, are only 140 feet high, but furnish the boilers with the required amount of air. Other boilers installed at the mill bring the total up to 21 in number, as stated.

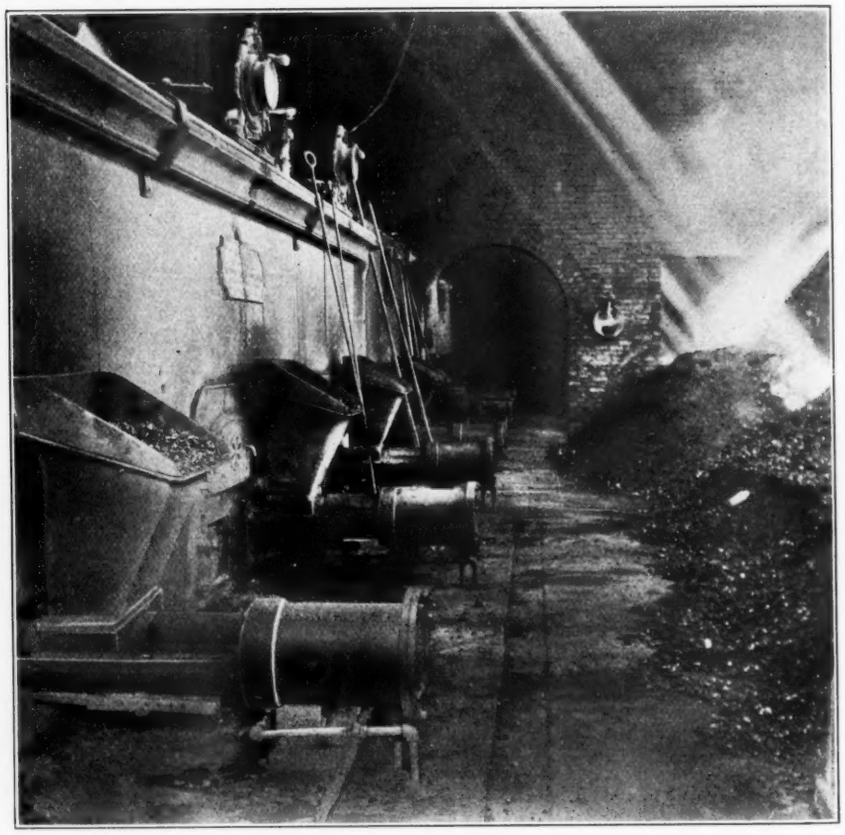


FIG. 3. A VIEW IN THE BOILER ROOM

Coal Consumption of Plant

This brief outline, along with the photographs, will give at least a general idea of the plant, so that an itemized account of the coal consumption will readily be intelligible. For the month of May, 1908, the amount of coal consumed in mill No. 1 was 2,169,600 pounds, making a daily average for 24 hours of 69,987 pounds. In the six boilers there are 232 square feet of grate surface, and on each square foot the average burning is 12.56 pounds of coal, the quality being mine-run, crushed. Of this coal, 2.7 pounds per horse-power per hour are consumed for all purposes, including bleaching; the total horse-power for the engines and fire pump in this mill averages 1070.

In mills Nos. 2 and 3 the coal consumed during the month was 2,919,400 pounds or 47.087 tons per 24 hours, which reduces to 2.3 pounds per horse-power per hour with the same kind of coal as used in mill No. 1. From an average of 10 sets of indicator cards, the engine horse-power was found to be 1708.

In the seven boiler furnaces in these mills there are 276 square feet of grate surface. It will be remembered that Jones Under-feed stokers are installed and that the boilers depend upon forced draft. The coal consumption per square foot of furnace per hour was 14.2 pounds. During one week in May, No. 3 mill was stopped, which, of course, lowered the consumption of coal for mills 2 and 3. The quality of coal varied in per cent. of ash from 5 to 20 per cent., according to tests made during the month; and per ton of paper manufactured, including fire protection to the plant, 3234 pounds of coal are burned.

Cleaning Water-tube Boilers

By Maurice W. Campbell

Some engineers have a mistaken idea that it is impossible to give water-tube boilers of, say, the Babcock & Wilcox type, a real good cleaning. These boilers can be cleaned and kept clean, although it may be somewhat difficult to clean some of them. Of course, one must have the proper tools to do the work with. The cleaning must be begun right. Start about six months before opening up the boiler for internal cleaning, and do not think for a moment that the boiler is going to be cleaned in one day, because it simply cannot be done. It takes three to four

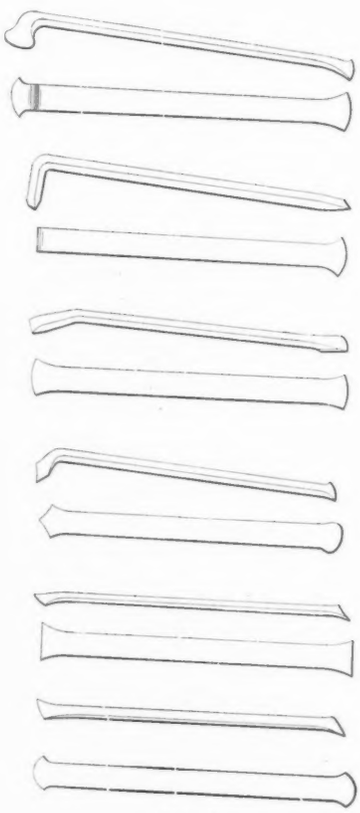


FIG. 1

days, depending upon the size of the boiler and the internal condition. A 300-horse-power boiler, under fair conditions, will take four men three days to clean, and they will not have time to do any loafing over the job. It will cost $40 to $60, according to condition, but the cost will more than repay the owner by the amount of coal saved in six months.

Then there is another saving to be considered. Cleaning a boiler means also that by removing the dirt and scale from its internal parts we allow the water in the boiler to come in direct contact with the iron or steel, thus greatly aiding evaporation. This in itself is gratifying to the engineer and fireman, as it means less work in holding the steam pressure, and it is pleasing to the owner, because he knows he can add more work to his machinery. Suppose a 300-horse-power boiler is coated with 1/16-inch scale, which, according to experiments, means a loss in evaporating power of 10 per cent., or in other words, instead of the boiler developing 300 horse-power, we would get 270 horse-power. But if this 1/16 inch of scale is removed we once more get the 300 horse-power. Thirty horse-power does not amount to much, perhaps, but for 10 hours per day it means a loss of 300 horse-power, or 1800 horse-power for one week and 93,600 horse-power for one year. This does not mean that pounds of coal equivalent to 93,600 horse-power is being saved after the scale is removed, but it means that nearly 10 per cent. more coal is being used in keeping up the 270 horse-power than should be. That is, we should get 300 horse-power for the same amount of coal that is now consumed for the production of 270 horse-power.

Preparing to Clean the Boiler

As stated, one should begin cleaning his boiler about six months beforehand. The first thing is to find out how many cubic feet of water is consumed in the boiler in 24 hours. Suppose 1000 cubic feet to be about right. That would require one pound nine ounces of sal soda, which should be properly prepared before using. If the water is pumped from a croton tank to a heater, there are no changes to make; but if there is no tank, one will have to be provided for the purpose. A clean oil barrel will answer very well. This should be connected to the suction of the pump. Next take a sheet-iron pail and put in it one pound nine ounces of sal soda, filling the pail two-thirds full of water. Place it under a steam pipe and boil the water until the soda has been dissolved. Then pour the contents into the tank, having first filled the tank with water.

This amount of sal soda must be pumped into the boiler each day for six months. At the end of that time the scale should be so loose that with proper tools it can be easily removed. There will be needed six 14-inch flat files. Heat them one at a time and bend four of them as shown in Fig. 1. Then all are heated a cherry red and plunged into clean, cold water. When cold, the ends are ground sharp. These tools are used for scraping scale out of headers and drums and off of clamps, caps, nuts and bolts. The clamps, caps, nuts and bolts should be soaked in kerosene oil a few hours before starting to scrape them.

Two good tubs can be made out of an oil barrel. Fill each tub half full of kerosene and put the parts to be soaked in one tub. Then as each piece is scraped put it in the other tub for washing. From this tub the caps and nuts will have to go under another cleaning; that is, a facing-up. A carpenter's brace, a flat piece of 12x12x1¼-inch board, smooth on both sides, a socket and a plug will be required. One end of the socket is to be fitted into the brace and the other end into the nut; one end of the plug is to fit into the brace and the other into the hole of the cap. Tack a few sheets of No. 2 emery cloth upon the board (see Fig. 2), put the plug in the brace and turn the cap around on the emery cloth, bearing lightly on the brace until the face of the cap is bright and smooth. Then turn it up and put the plug in the hole from the inside and turn the cap as before until this face is bright and smooth. Be sure and not let the cap wobble, or the face will not be true. Care must be taken to keep both the cap and nuts perfectly flat on the board while grinding the face.

Next a face grinder will be needed for the header where the cap fits. This can be easily made, as per the small sketch in Fig. 2, in which the part *A* should be somewhat smaller in diameter than *B*; this is to permit the projection *A* to fit in the hole in the header and act as a guide for *B* to keep *B* turning in a true circle while grinding the face. The emery

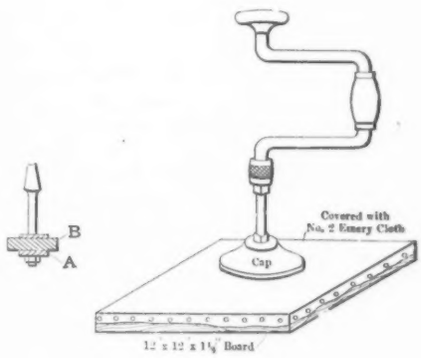


FIG. 2

cloth is cut to fit *B*, punching a hole in the center so it will fit over the bit; then putting *A* on the bit, screw up on the nut. This will force *A* down on the emery cloth and hold it tight while grinding the face.

The Drums, Tubes and Headers

Run the tube-brush through each tube, then blow steam through each by means of a hose. This will clear all the loose scale out of the tubes. Give the headers a good scraping, then get into the drums and give them a good scraping along the seams and around the rivet heads. Gather up the scale so far removed, weigh it and enter the weight in a note-book for future reference.

Then, to close up the boiler: First, all joints must be wiped clean and dry, and a thin coating of pipe-joint grease applied, putting a little on the threads of the nuts and bolts. Put on all the caps and screw them up. After the boiler has been closed up good and tight, begin filling it and, if possible, put on a cold-water test to make sure that all joints are tight. The boiler

is now ready for service, and is clean, of course.

The use of the sal soda should be continued, as stated. Every day the boiler is operated, use the same amount of sal soda as mentioned, and it will keep the boiler in good condition.

As for the tools used for grinding the caps, etc., these can be bought at the boiler maker's and are not very costly. I believe it would cost more to make one than it could be bought for. The brush the writer uses in cleaning the tubes is a twisted-wire brush.

Chimneys for Factories

By H. E. Colson

The construction of chimneys for factory purposes has emerged from the artistic to the utilitarian stage, inasmuch as it has been realized that fine appearance should, in the case of factory buildings, be subordinated to low first cost.

Among the newer styles of chimneys to be seen are the ferro-concrete structures, erections in steel, and brick chimneys of exceeding plainness. A few notes on the principles underlying the correct formation of chimneys for manufacturing purposes may not be without interest.

Avoid Long Flues

Long flues leading from the furnace to the chimney should be avoided if possible. Modern tendencies are all in favor of a direct up-draft from the boilers as free as possible from angles, bends and constricted passages. The heat of the chimney is of great importance to the draft, and it is necessary in order to obtain proper buoyancy of the furnace gases in the chimney that the temperature should not fall below, say, 500 degrees Fahrenheit at the base.

This very often involves the incorporation of the chimney structure into the main design of the building, and in many modern instances it has been found desirable to construct the chimney of steel and incorporate the steel work with the skeleton frame of the building. Security from lateral stresses due to wind pressure is obtained by means of guy ropes, although these are gradually being abandoned as more confidence in the stability of steel structure is being obtained. This movement is being hastened by the fact that the efficiency of a chimney is proportionate to the square of the diameter of the flue and to the square root of the hight of the chimney, so that it pays from utilitarian reasons to construct a chimney of as short and thick a nature as is consistent with obtaining the proper hight of the hot gases of combustion to secure a natural draft.

The steel chimney possesses the further advantage that it is not so easily deteriorated as brickwork by the mixing of escaped steam with the furnace gases. It is well known that hot steam has a very bad effect upon brickwork and where it is desired for architectural reasons to use brickwork it is a useful idea to construct this merely as a casing and to carry a steel chimney for, say, two-thirds of the hight up the interior of the up-take.

Lining for a Brick Chimney

A brick chimney should be lined with a separate and detached ring of fire-brick up to a point where the hot gases can no longer exercise a deteriorating influence on the ordinary brickwork. This frequently extends to two-thirds of the hight of the chimney. The outer shell of ordinary brick should be pierced by five or six vent holes, say 15 feet above the ground level, and the second ring of vents about 20 feet above this, in order to avoid stagnant air between the two rings of bricks. The brickwork toward the base of the chimney should preferably be finished in cement, while nearer the top in order to provide sufficient flexibility in the presence of high wind pressures it is advisable to use ordinary mortar. This point has been, in the writer's opinion, rather overlooked by the designers of concrete and concrete-steel chimneys. The use of concrete involves a certain rigidity of structure in excess of that of brickwork or pure steel, and it requires very careful planning in order to insure that the bonding of the concrete by means of steel straps shall be uniform, so as to resist wind pressure in whatever direction it may come.

Protection Against Lightning

All chimneys should be provided with efficient means of protection against lightning, and this is most easily done by arranging down the exterior surface of the chimney a copper strip of ample cross-section, secured to the brickwork by means of copper bonds. The use of iron in conjunction with copper in exposed situations is not to be recommended on account of possible electrolytic action. The top of the chimney should be surrounded by a band of copper and from this should project at intervals, around the circumference at the top of the chimney, spikes which serve to collect any electric discharge. Care should be taken to make the band of the copper conductor as straight and free from kinks as possible.

It is well known that a lightning discharge is intensely oscillatory in character, having a very high period, and the effect of the slightest angle in the conductor is to produce an inductive voltage which may tend to choke back the flow of the electric discharge and cause it to seek other paths to the ground, damaging all objects in its course. This is probably the reason for many mysterious wreckages of brickwork on buildings which have apparently been protected by lightning conductors. The straps should be connected at the base of the chimney with an efficient ground. This is best afforded by means of a pit of coke, say a 6-foot cube into which the copper strip is led, coke being itself a fairly good conductor and also collects moisture. The discharge is led away to the earth in a direct and easy manner.

Foundations Must Be Substantial

Trouble is sometimes caused in chimneys belonging to industrial buildings by the fact that these buildings are erected on land which could not be used for ordinary building purposes owing to its softness and its being adjacent to river beds. It must never be forgotten that the weight per square foot imposed on the ground is greater in the neighborhood of the chimney than in any other portion of the building, and where the factory is erected on land which has been originally marshy it is advisable to thoroughly pile the ground before erection of the chimney, bonding the heads of the piles by means of a thick bed of concrete. In one case in the writer's experience it was found advisable virtually to float the chimney on a raft, extending over a considerable area, consisting of old railway rails embedded in concrete. Such structures should be carefully watched and if there is the slightest sign of subsidence, provision should be made for piling the ground around about, as it not unfrequently happens that beds of running sand are discovered underlying factories adjacent to waterways. The maximum pressure on earth near waterways should not exceed 6000 pounds per square foot.

Steam-Electric Plant in a Western Mining Camp

By A. J. Anderson

Situated in the northern part of Wyoming, on the C., B. & Q. R. R., is the steam-electric plant of the Carney Coal Company, where lignite coal is mined.

The Boilers

In the boiler room are two batteries of 72-inch by 18-foot return-tubular boilers, each containing seventy 4-inch tubes. The boilers of one battery have double butt-strap seams, and were made by the Kewanee Boiler Company. The other boilers were built by the Erie City Iron Works, and are equipped with domes, the seams being of the lap-joint type, double riveted. One hundred pounds pressure is carried. The boilers are all fed through the blow-off and are hand-fired.

Boiler Feeders

The boilers are fed by a 10x11x12-inch direct-acting Dean pump which takes water at 196 degrees Fahrenheit from two

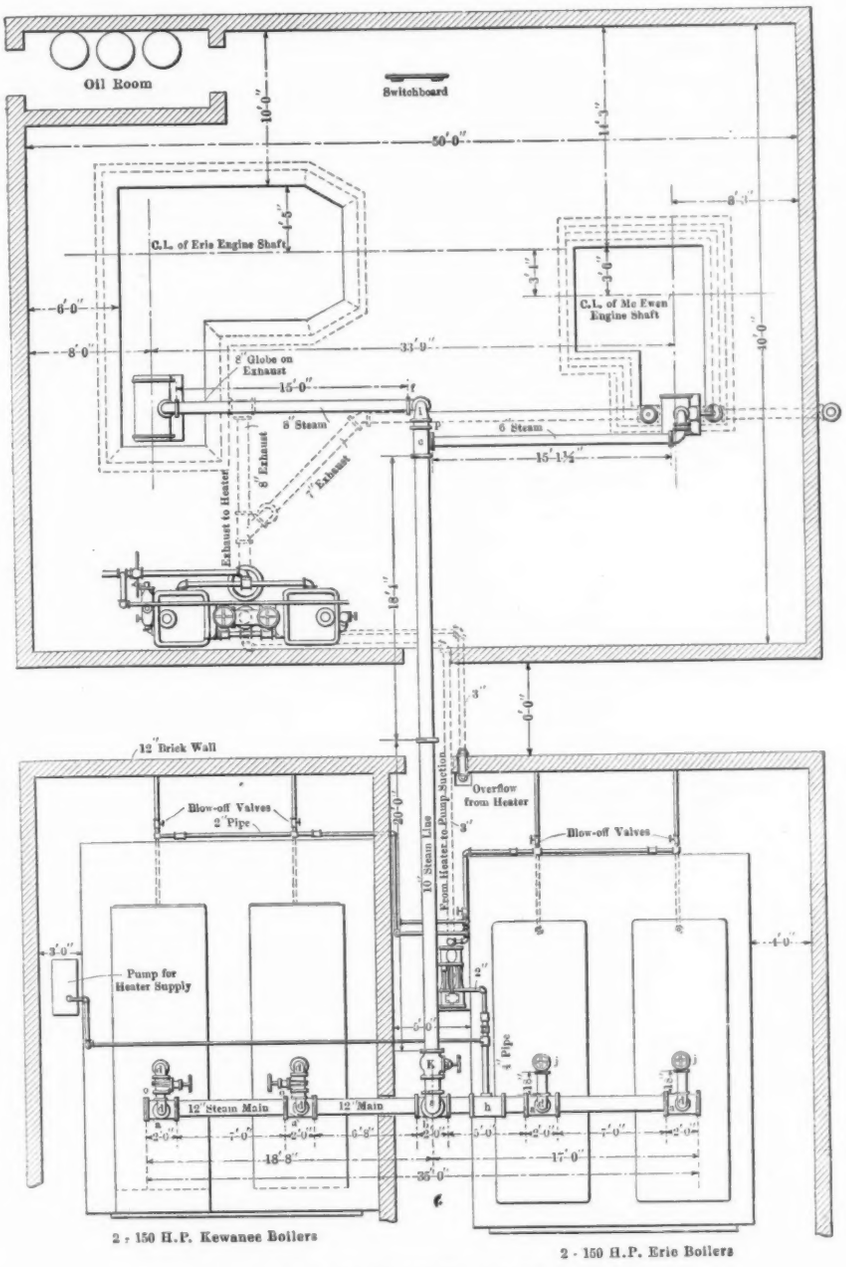


FIG. I. LAY-OUT OF BOILER AND ENGINE ROOMS

Cochrane heaters in the engine room. Two injectors are used when the plant is not in operation and no exhaust steam is available.

Engines and Generators

The two direct-connected units, Fig. 2, are used for power and lighting. One is an Erie City engine, 19x21, of the four-valve type. Corliss exhaust valves are used and double-ported balanced steam valves under the control of a variable-throw eccentric actuated by an automatic governor of the shaft type. It runs at 206 revolutions per minute and is direct-connected to a 175-kilowatt direct-current generator. It was made by the Goodman Manufacturing Company, of Chicago. The other unit is a 16x16 McEwen engine direct-connected to a 100-kilowatt Goodman dynamo. Both generators are of 275-volt potential and are rated at 360 and 650 amperes, but they are excessively overloaded for short periods.

The Switchboard

The large panel of the switchboard is used as the main generator panel and the small panel for control of the ventilating fans, one of which is running at present, and an 8x20-foot fan is being installed. Lights for the camp are furnished from the plant.

Water Supply

An 80,000-gallon tank, partly shown in Fig. 2, is used as a supply tank. Mains run up to the camp and the water supply is taken from a well near the tipple by a 6x4x8 Cameron pump. The water for the boilers is taken most of the time from the Tongue river, a mountain stream about 800 feet distant. There is also a 12x17x12 Deane of Holyoke, duplex double-acting pump of 500 gallons per minute capacity situated in the boiler room, taking water from a well located near the river. It has an 8-inch suction line and a 6-inch discharge to the tower tank. The piping is so arranged that all three pumps pump through the 6-inch line into the tank.

One of the best methods of checking corrosion in a boiler is to have zinc plates hung in it. Attach them to the tubes and braces. The galvanic action will then eat the zinc instead of the boiler. Especially is it necessary to use zinc if there is a surface condenser in the plant. The brass tubes of the latter set up an action that is liable to ruin a boiler in a few months, if something is not done about it.

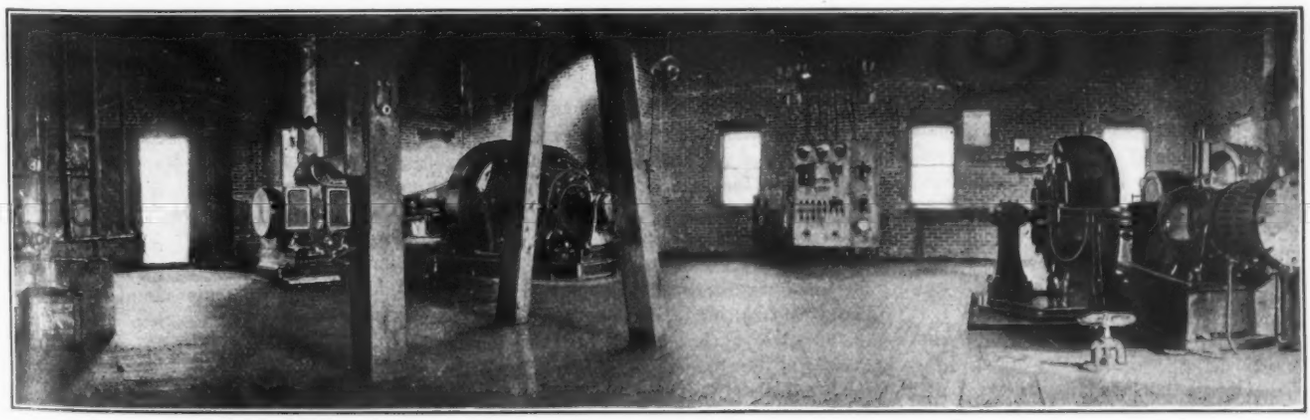


FIG. 2. VIEW IN ENGINE ROOM OF CARNEY COAL COMPANY'S PLANT

Designing Wheels for Corliss Engines

Plain Directions for Determining the Required Diameter and Face, and for Finding the Proper Weight of Wheels for Various Cases

BY L. L. WILLARD

An engineer who has designed a large number of wheels can tell very closely by looking at a drawing if the wheel is well proportioned and the metal so distributed as to be used to the best advantage. The size and number of arms, bolts and links do not vary greatly in proportion for any similar type, a practically constant relation being maintained where they are designed for a given rim velocity.

In these days of active competition it is imperative that the metal be used to the best advantage. It is, therefore, necessary to understand the rules which limit us and which we cannot go beyond without the liability of serious consequences, the bursting of a wheel often causing the loss of life.

Belt Wheels

It has been found by experience that if a belt wheel or pulley for an engine is constructed strong enough to transmit the power and contains sufficient metal to take up the strains developed, that for ordinary cases the weight will be all that is required for balancing purposes.

Where a close regulation is required, such as belting to generators, more especially those of the alternating-current type, this statement does not always hold good. Two per cent. regulation, that is, 2 per cent. change in speed either side of normal, is usually all that will be required to secure the steady burning of lamps. More weight should be added to the rim of the wheel when the conditions warrant, as in office buildings using both power and light. The methods of determining the amount of weight for various cases, as given under "Balance Wheels" to follow, will also apply to belted engines driving generators.

In designing a belt wheel, the first dimensions to determine are the diameter and face. The peripheral speed or the velocity of any point located on the rim should not be much over 4800 feet per minute. From this figure the diameter can be determined as follows:

$$\textit{Diameter in feet} = \frac{4800}{3.1416 \times R.P.M.}.$$

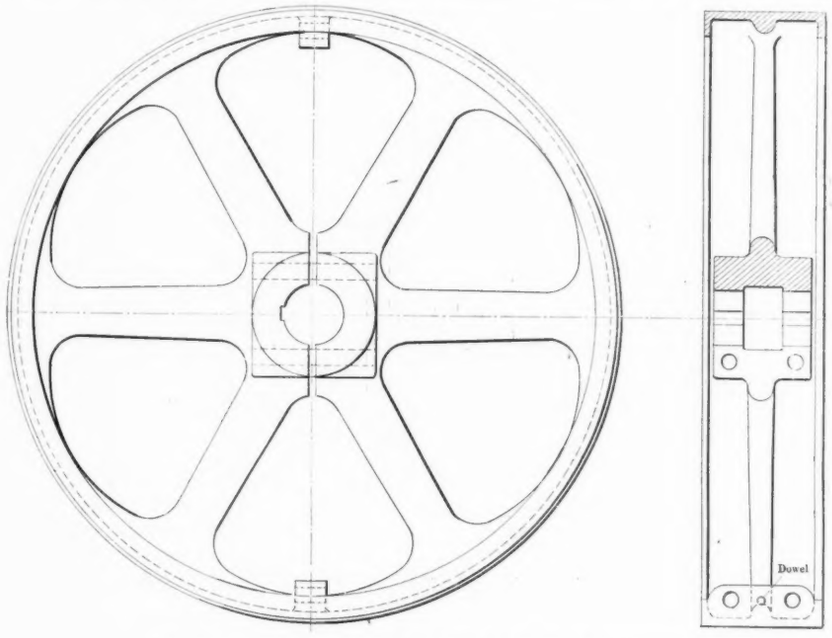
Table 1 will be found useful in selecting the proper diameters for a given number of revolutions per minute. There will be found many cases without doubt where the belt speed exceeds the above allowable velocity, but the life of the belt is shortened and at a speed much beyond this the centrifugal force of the belt must be taken into account, as it will reduce the amount of power transmitted.

Next, the necessary face of the pulley will be required. It should be wider than the belt by 1 inch on the smaller sizes to 2 inches on the larger pulleys. The width of the belt can be found by means of the horse-power formulas in general use, but the author has obtained good results from the following rule for getting the width of double belts such as are used as main driving belts for engines and large pulleys:

A double belt 1 inch wide, at a speed of 4800 feet per minute, will transmit from eight to ten horse-power with a minimum amount of slippage.

The actual amount of power transmitted depends a great deal upon the arc of contact of the belt on the driven pulley. If the surface of the belt covers much less than 180 degrees, slippage, with a consequent decrease in power, will follow. It is, therefore, desirable to have the driven pulley of as large diameter as possible and located at such a distance from the engine pulley as to give plenty of contact. A five-to-one ratio is considered about the maximum, that is, the diameter of the driver should not be more than five times the diameter of the driven. The top side of the belt should be slack so as to increase the arc of contact, and tighteners should not be used on any main drives, but avoided by the proper proportioning of the pulleys and regulating the engine speed to suit.

Wheels under 14 feet in diameter should have rims at least ⅞ inch thick, reinforced by a central and side ribs, as shown in the illustration. If the face required is over 40 inches, a double set of arms should be used, the sets being "staggered." Wide-face wheels are often built up of two or more single wheels bolted together at the rim flanges. This construction has the advantage of small castings and ease of handling for shipment. One-eighth of an inch to the foot taper is the usual practice for crowning the face.



CONSTRUCTION OF WHEEL UNDER 14 FEET IN DIAMETER

Rim joints are constructed in various ways, one of the most common and efficient designs being shown in the drawing. Each half is cast separately, with sufficient metal allowed at the joint for finishing on a planer. The halves are then doweled and bolted together, being ready for turning and boring. From ¾- to 1-inch clearance is left between the two faces of the hub so that it may be clamped solid on the shaft. Some builders cast their wheels in one piece, leaving at the rim joints and hub several slots into which wedges are driven to split the wheel apart before machining it. When the halves are put together again, the rough parts line the

two halves up, so that dowels are not required. This construction is considerably cheaper, as no planer work is required except that for the keyway in the hub.

In diameter the hub should be at least twice the bore, and the length about one and one-half times the bore, so as to secure a broad bearing on the shaft and prevent any tendency of the wheel to wobble sidewise. The center may be cored out as shown for one-third of its length.

Up to and including wheels 16 feet in diameter, six arms are ordinarily considered sufficient; above this eight arms until wheels of 24 feet diameter are reached, where ten or more arms are used of the built-up construction. The size of bolts, rim joints, and arms can be determined by applying the formulas for balance wheels, which follow.

TABLE 1. MAXIMUM SPEEDS, AVERAGE AND MINIMUM WEIGHTS.

Diam. of Wheel in Ft.	Max. No. of Rev. per Min. Rim Speed, 4800 ft.	Max. No. of Rev. per Min. Rim Speed, 5700 ft.	Average Wt. for Belt Wheels.		Minimum Wt. for Balance Wheels, lb.
			Face, In.	Weight, lb.	
8	191	227	12	4,000	4,500 in halves.
9	169	201	15	4,500	5,000 "
10	152	181	20	8,500	8,000 "
11	139	165	24	9,400	9,500 "
12	127	151	27	12,000	12,500 "
13	117	140	30	13,250	15,000 "
14	109	130	33	14,500	18,000 "
15	101	121	35	16,500	20,000 "
16	95	113	37	18,500	24,000 "
18	85	101	42	25,000	27,000 "
20	76	91	50	42,000	32,000 "
22	69	82	60	52,000	65,000 segments.
24	63	76			80,000 "
26	58	70			
28	55	65			
30	51	60			

Weight of Balance Wheels

The balancing effect of a wheel is WR^2, where W equals the weight of the wheel in pounds and R equals the radius of gyration in feet. The radius of gyration is the distance from the center of the wheel to an imaginary point at which the whole weight can be assumed as concentrated. In a well-designed wheel this will be from 0.37 to 0.43 of the diameter in feet. It can be calculated accurately by taking separately the hub, arms and rim and combining the results. The formula for finding R is given in most hand-books.

If the WR^2 of two wheels are equal, the balancing effect is the same, regardless of the fact that they may be of different diameters and weights. It can readily be seen that the greater R becomes, the less weight will be required to secure a given balancing effect. It is, therefore, desirable to use as large a diameter of wheel as possible to keep the weight down. A heavy wheel, besides costing more for material, requires a larger shaft and bearings, so that the weight not only affects the cost of the wheel, but other parts as well. Also, if shipment of the completed engine is for a long distance or cartage on trucks is necessary, the expense will be increased considerably.

An accurate method of ascertaining the proper weights for any case, is to start with the indicator card, lay out a crank-effort diagram, and from this construct a curve showing when energy is put into the wheel and when given out. From these data the angular variation per revolution can be computed for different weights. This is a long method and for most cases it will be sufficient to base our figures on results that have given satisfaction in actual operation.

As a guide, Table 2 has been prepared so that the weight of wheels for various cases can be computed with a fair degree of accuracy, the constants being based on installations which are running satisfactorily. By referring to Table 1 a diameter can be selected with reference to the revolutions given in the third column, the rim speed not exceeding 5700 feet per minute. After the diameter is determined, a constant can be taken from Table 2, using the constant suitable for the case in hand. The second column is to be used when the engine is to drive alternating-current generators of a frequency of 60 cycles and operating in parallel with other units.

TABLE 2. VALUES OF CONSTANT K.

Diam. of Wheel, Ft.	A. C. Current. Parallel Operation.	D. C. Current. and A. C. Current.
10	585	270
11	485	225
12	400	185
13	350	160
14	300	135
15	260	120
16	230	105
18	185	85
20	145	65

The third column is to be used when the engine drives direct-current generators and alternating-current generators not in parallel. The constants are based on engines running 100 revolutions per minute and of the single-cylinder type. The number of cylinders and their arrangement modify these constants to a certain extent. In the case of a cross-compound engine with the cranks set at 90 degrees, that is, one in advance of the other by that amount, the impulses are four instead of two per revolution, which consequently causes a more even turning moment of the engine and allows a reduction in weight of the wheel for the same regulation.

Assuming the constants given in Table 2 for single-cylinder engines to represent 100 per cent., the constants for other types can then be modified as follows:

Single-cylinder, per cent.	100
Tandem-compound, per cent.	80
Cross-compound, per cent.	60

For any given engine driving a generator of a given kilowatt capacity the total weight of wheel equals the proper constant K times the kilowatts. If the number of revolutions is more or less than 100, use the following constant for alternating-current, parallel operation:

$$K_1 = \left(\frac{100}{R.P.M.}\right)^4 \times K.$$

For direct-current and alternating-current operation not in parallel, use the following:

$$K_2 = \left(\frac{100}{R.P.M.}\right)^3 \times K.$$

After the weight has been determined, the last column of Table 1 should be referred to, for the minimum amount of weight should not be under the figures given. It is possible to design wheels of weights considerably less than given in the table, but the appearance must be taken into consideration. If it is aimed to keep down to the very minimum, and still present a design which will not look weak and have the appearance of going to pieces, should the engine exceed its normal number of revolutions by a few turns, the figures should be adhered to rather closely.

Some assumptions have been necessary on the weights and sizes of the rotating parts of the generator. These have been averaged from figures of the three leading electrical manufacturers. As the WR^2 of the armatures and rotors amount to only one-eighth to one-twelfth of that of the wheels, the effect on the total weights, except on the largest sizes, does not make a very noticeable change. Two examples have been worked out to show the method of applying the constants to different cases.

Examples

1. A tandem-compound engine is direct-connected to a 500-kilowatt 60-cycle alternating-current generator, running at 90 revolutions per minute. Find the diameter and weight of wheel.

From Table 1 it will be seen that the largest diameter of wheel is 20 feet. From Table 2, $K = 145$ for 100 revolutions per minute.

For 90 revolutions per minute

$$K_1 = \left(\frac{100}{90}\right)^4 \times 145 = 220.$$

For a tandem-compound

$$K_1 = 220 \times 0.80 = 176.$$

Total weight of wheel =

$$176 \times 500 = 88{,}000$$

pounds.

2. A single-cylinder engine is direct-connected to a 75-kilowatt direct-current generator running at 120 revolutions per minute. Find the diameter and weight of wheel.

From Table 1 the largest diameter of wheel is found to be 12 feet, and from Table 2 $K = 185$ for 100 revolutions per minute.

For 120 revolutions per minute

$$K_2 = \left(\frac{100}{120}\right)^3 = 185 = 107.$$

Total weight of wheel =

$$107 \times 75 = 8025$$

pounds.

By referring to Table 1, it will be seen that the minimum weight for a 12-foot wheel is 12,500 pounds, so that either an 11- or 10-foot wheel will have to be used and the weight re-calculated.

For an 11-foot wheel

$$K_2 \quad \left(\frac{100}{120}\right)^3 \times 225 = 130.$$

$$130 \times 75 = 9750$$

pounds, which is just above the limit. This would be called an 11-foot wheel of 10,000 pounds.

Pump Practice in Great Britain

By William H. Booth

In the ordinary power station, three classes of pump are used: the air pump, the circulating pump, and the feed-pump. Before the days of the high-speed engine, the air pump was usually driven by the main engine, but the high-speed engine has altered this and the separate condenser and pump unit is now the rule. There is, however, an advantage in the air pump driven from the main engine, inasmuch as it gets its power from steam used with greater economy, which cannot be the case where the separate pump is installed.

Air Pumps

A fault of the independent air pump is that it can be run at any speed with the result that when air leakages occur in the pipe system, instead of finding and remedying them, the pump is usually speeded up to maintain the vacuum. In one case, after operating months with a 16-inch vacuum, the engineer in charge discovered an air leak which, when stopped, was shown to have been equivalent to an extra 10 inches of vacuum.

One class of pump which is coming much into use is the Edwards air pump, which has the ports and piston so arranged as to do away with the suction valves in the air cylinder.

For supplying the ejector type of condenser and for furnishing circulating water for all types of condensers, the centrifugal pump, electrically driven, has an efficiency of about 40 per cent. from current consumed to water horse-power. It is inexpensive, occupies little space, and will throw a large stream of water; there is likely, however, to arise the tendency to pump more water than is necessary, thus cooling the condenser water in the effort to cover up air leaks and wasting energy by so doing. Any condenser temperature less than 100 degrees Fahrenheit would seem to indicate an excessive use of cooling water.

Feed Pumps

Perhaps in no detail has there been so great diversity of practice as in feed-water pumps. In the North, the tendency has been to use the crank and fly-wheel type with plunger. It runs slowly, and gives excellent service, and when run at high speed makes a good fire pump.

No one seems to know just how much steam direct-acting pumps do use, but their want of economy is often increased by feeding through long, uncovered pipes, resulting in a pump driven largely by water rather than steam pressure. When cheaply made, such pumps leak steam badly as well as devouring it, with a resulting enormous waste.

As if the pump had not already enough handicap, it is usually located in the boiler room and covered with dirt and ash and so placed as to be in strong drafts of cold air which amply aid the condensation of steam in pipes and cylinders.

When feed-water must be obtained from a deep well, the pump to be employed must be chosen according to circumstances. From a bore hole of 10 inches diameter, a single barrel pump will raise about 7000 gallons an hour and will work for long periods without breakdown. The pump barrel is usually attached to the end of the riser main and lowered down the bore hole, the pump rod coming up inside the water main.

An 8-inch pump can be put inside a 10-inch bore hole, but an air-lift pump, if there be sufficient water to supply it, will yield many times the quantity that can be taken out with the ordinary deep-well pump. They are uneconomical, however, as they require about three times the power to raise a given weight of water that is used by the direct-driven steam pump. They must have, also, for economical working, a depth of well greatly in excess of the distance from surface to water level. The well may be at any distance from the air compressor, so that the power plant may be placed in the most convenient spot regardless of the location of the well, or a single plant may answer to pump a number of wells.

Drainage Pumping

For mere water-lifting purposes in large quantities through a small hight, perhaps the Dutch should be looked on as safe leaders, for fuel is not too cheap and water lifting is with them a prime factor in the preservation of dry land. One form of water lifter used in Holland is the scoop wheel which is not unlike a low breast wheel with long, straight buckets so placed as to rise nearly vertically out of the delivered water. Wheels of 30 feet diameter will lift a large body of water perhaps 4 feet.

But even in Holland the centrifugal pump has displaced the old lift pumps of bucket type and the Haarlem Meer is now largely drained by means of centrifugal pumps directly connected to steam engines. Centrifugal pumps have also been used at Liverpool to increase the depth of water in certain of the older docks in order to fit them for vessels of deeper draft, the cost of pumping being less than the cost of deepening the dock otherwise limited as to its water level by the rise of the tide.

Centrifugal pumps are also much used in connection with town-drainage systems. Thus, in London, the main drainage outfall sewers are supplied with lifting pumps which raise the sewage to a continuation at a higher level. The main sewer is thus a great hight above the district beyond the pumping stations. Those districts pump their sewage by means of the usual slow-running beam engines, but in times of heavy rainfall the supply becomes excessive and the storm water is raised simply to the level of the Thames by large centrifugals which deal rapidly with many millions of gallons.

Air-lift pumps, or *emulseurs,* as the French term them, are sometimes made to lift water from the surface by constructing a bore hole simply to give immersion. It has been proposed to raise water to cooling towers, taking advantage of the expanding air to cool the water. Obviously, however, this would be wasteful. The volume of air would be large and would demand large compressing machinery and the system could not be at all complete. Indeed, it is doubtful if any real gain is secured in cooling towers by using fan-propelled air in place of the natural draft tower.

Power-house Systems

While in the foregoing only the main types of pump have been briefly sketched, enough has been said to draw attention to the heterogeneous complexion of the modern power station.

A station now prominently before my mind contains, as its assortment of pumps, a steam-driven vertical air pump by a firm we will call *A*. There is a feed-pump by *B*, a circulating pump by *C*, of centrifugal type, a return-water pump to the high tank and a second electrically driven ram feed-pump. Every one of the pumps bore the stamp of its designer and was, therefore, of distinctive appearance, the re-

sult being a want of uniformity in appearance not conducive to pleasing effect.

The old idea was to drive everything off the main engine. Thus in the beam engine there was attached to the beam the air pump, the cold-water pump and the feed-pump. There was no way to feed the boilers when the engine was stopped. Locomotives, before the invention of the injector, had to run many idle miles to fill their boilers. The inconvenience of this in regard to stationary engines caused the invention of the separate feed-pump, and the competition for cheapness has resulted in present-day bad practice.

Engineers have begun to find out for a second time that main engines are apt to be more economical than small engines of any type, but only by means of electricity has it been possible to drive pumps at nearly the economy of main-engine power, The electric generator and motor furnish power to auxiliaries at about 80 to 90 per cent. of distribution efficiency from the engine brake horse-power.

It only remains to couple the motor to the pump in an efficient manner. A pump and an electric motor are somewhat incompatible, for one runs fast and the other slow. An electric pump may be double-geared down from the motor by means of rawhide gears, but rawhide gears must not be run in a hot, dry atmosphere, and at best gearing is not highly efficient.

Feed-pumps may be driven by worm gears with fair efficiency. To insure this, however, the angle of the thread should be 45 degrees, an angle that appears rational if it be considered that an angle of 90 degrees is all pressure but gives no movement, and an angle of 0 degree produces no pressure, but a maximum of rubbing movement of the worm and wheel; hence it is argued the halfway measure of 45 degrees should prove best, and practice appears to uphold this angle.

For air pumps, Ferranti has adopted a rope drive from the main engines, and probably no cheaper system is possible. In electrical work there is, however, always present the fact that the main-engine shaft has enough on it already. In a condensing plant where there is an air pump, it is worth considering whether all the accessories cannot be driven by one auxiliary engine of good design, retaining an injector as a standby feed-pump.

Generally, and to sum up, it must be said that the auxiliaries of electrical engineering have been sadly overlooked by engineers as a rule. Great thought has been expended on dynamos and engines, and even boilers have been given some slight attention, but beyond that point all things are classed as so much detail to be bought by Dutch auction off the shelves of any merchant firm.

But this era appears to be drawing to a close, and more attention is now likely to be given to quality as distinguished from mere low prices.

Curing a Pounding Pump

By William Kavanagh

In a compound pump a heavy pound developed in one of the low-pressure cylinders, which are 34 inches in diameter by 26 inches stroke. Owing to the size and weight of the parts to be removed

FIG. 1

FIG. 2

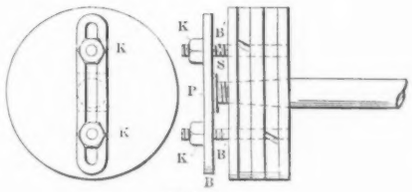


FIG. 3

in order to effect a repair, it was considered good policy to let the knock continue for some time so as to be in a position accurately to locate the trouble before proceeding to take the pump apart. It was decided that the piston was loose on the piston-rod and to remedy the trouble the cylinder-head must be removed and the nut on the piston-rod tightened.

Preparatory to taking off the cylinder-head, a line was dropped from the ceiling and lined vertically with the center line

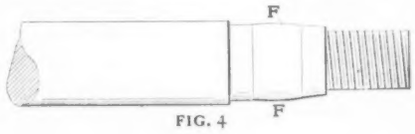


FIG. 4

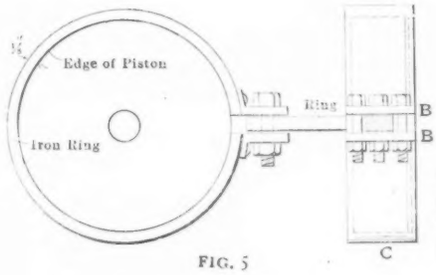


FIG. 5

of the cylinder-head. The point so located on the ceiling was marked and a ring bolt inserted. From the ring bolt was suspended a chain hoist, and two eye-bolts were screwed into the cylinder-head. The chain hoist was attached to the eye-bolts by means of a piece of rope, and by lifting the cylinder-head until its weight was carried by the hoist, it became an easy matter to slide the head out onto some strong planking that had previously been arranged to receive it.

After the head was removed a wrench formed like Fig. 1 was placed on the nut, which was pulled up about three-quarters of a turn, and the head was put back in position. After the pump had performed its regular duty for a few weeks, the pound again developed, and this time it was decided, if possible, to effect a permanent repair. To do this it would be necessary to pull the piston off the rod and investigate.

Reference to Figs. 2 and 3 will show the method of removing the piston. Locknut *N* was taken off, and two 1-inch holes were drilled in the piston, which was solid, and tapped to receive two 1-inch stud-bolts, each 10 inches in length. A strong link was then placed over the stud-bolts across the end of the piston-rod and secured with nuts and washers, as indicated in Fig. 3. By screwing up on the nuts *K K* and striking the link at the point *P* with a heavy sledge hammer, the piston was removed without involving much labor. To protect the piston-rod center from injury that might result from the use of the sledge, a flat piece of soft iron was inserted between the piston-rod end and the link, as shown at *S*.

In removing the piston from the cylinder it is evident that the piston rings would get out of position, and in replacing the piston would have to be compressed into place. To obviate such trouble, a ring of flat iron was gradually pushed over the piston rings as the piston was being withdrawn from the cylinder. In like manner when the piston was being put back in the cylinder, the ring was slipped outward as the piston was forced inward, and in this way the insertion of the piston and rings was made considerably less difficult than it would have been without the aid of the circular band.

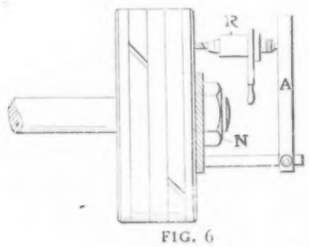


FIG. 6

As shown in Fig. 5, the ring is made out of heavy sheet iron about ⅛ inch thick, and is slightly greater in width than the thickness of the piston. Two pieces of boiler iron are riveted to the ring at *B B* to strengthen the band and admit of the bolts. The middle bolt is for the purpose of holding a ring for attaching a chain hoist, while the outer bolts are for the purpose of binding the band around the piston.

The method of holding the ratchet brace or "old man" in position in order to drill the holes in the piston to receive the studs is illustrated in Fig. 6. Nut *N* was screwed back from the piston far enough to admit the brace, and after the brace was in position was screwed up tight, the ratchet put in place and the holes drilled. The ratchet is shown at *R*, and it will be noted that with this method of procedure, holes can be drilled at any point around the piston-rod within the limit of the arm *A*.

A Peculiar Governor

By M. Eastman

The accompanying illustrations show a type of governor very seldom seen. This particular governor was found operating on a slide-valve engine in a packing house in the Middle West. The slide valve regulated the timing of the exhaust and was driven by a fixed eccentric, while the governor cut-off was operated by a second fixed eccentric and an eccentric-rod attached to a rocker-arm, the governor balls being revolved by means of a belt connection as in the ordinary type of governor.

The idea embodied in this governor is to obtain a variable cut-off on a slide-valve engine, and at the same time approach Corliss-engine economy as nearly as possible. The governor is attached to the inlet nozzle of the cylinder; steam is admitted at full boiler pressure and cut-off at a point corresponding to the load on the engine.

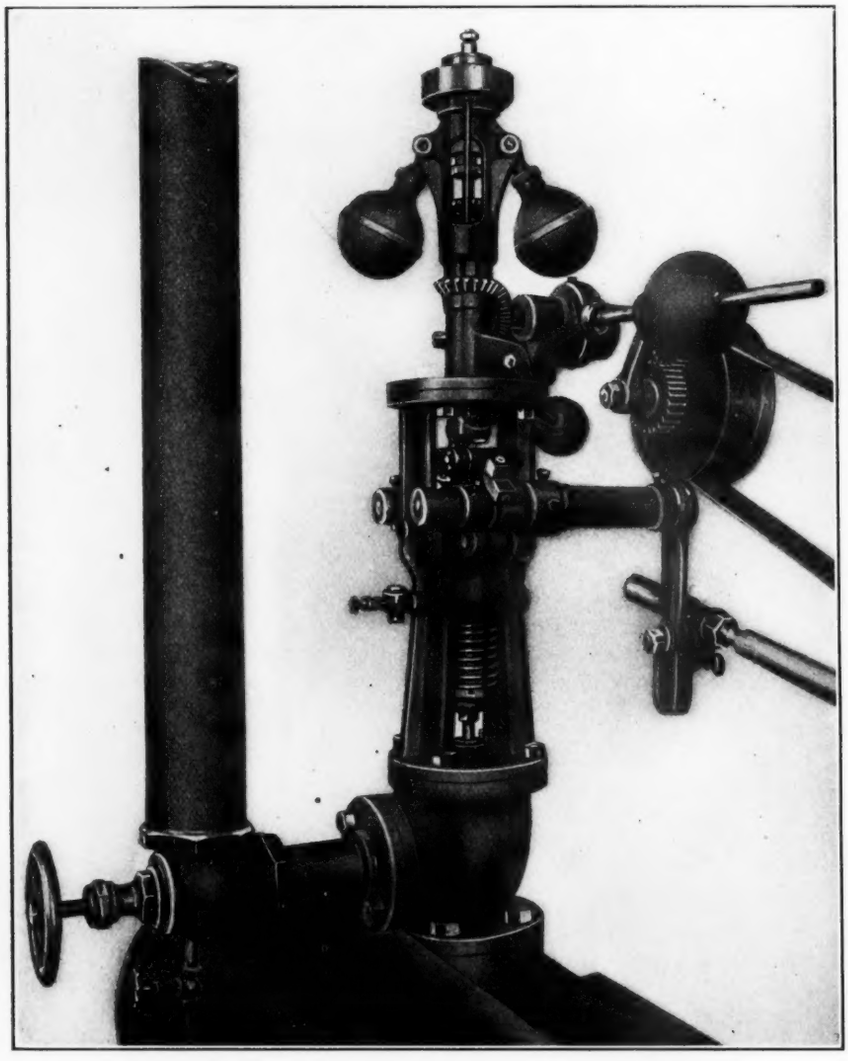


FIG. 1. THE GOVERNOR ATTACHED TO THE ENGINE

After the piston had been removed, an investigation and measurement of the taper on the rod and hole in the piston showed that the taper on the rod was full at *F*, Fig. 4. This fullness prevented an even bearing in the tapered hole of the piston, allowing it to move laterally and rock on the rod, which eventually caused the piston to become loose and pound. To remove this defect the piston-rod was placed in a lathe and turned true to the bore in the piston, and after the rod was replaced in position, the pump ran quietly and did not develop the sign of a pound.

The governor consists of a double-beat poppet valve operated by a double trip mechanism, as shown in Figs. 1 and 2, the first illustration being a photograph of the governor as it appeared on the engine, and the second a sectional view which shows the construction of the governor and valve in detail.

Referring to Fig. 2, it will be seen that the valve *A* is closed by means of the spring *B*, the tension of which can be regulated by the cup washer and nut *C*. As the arm *D* is operated back and forth, it operates the two rocker-arms *E* and *F* alternately, which lifts the valve-stem head *G* and the valve *A*.

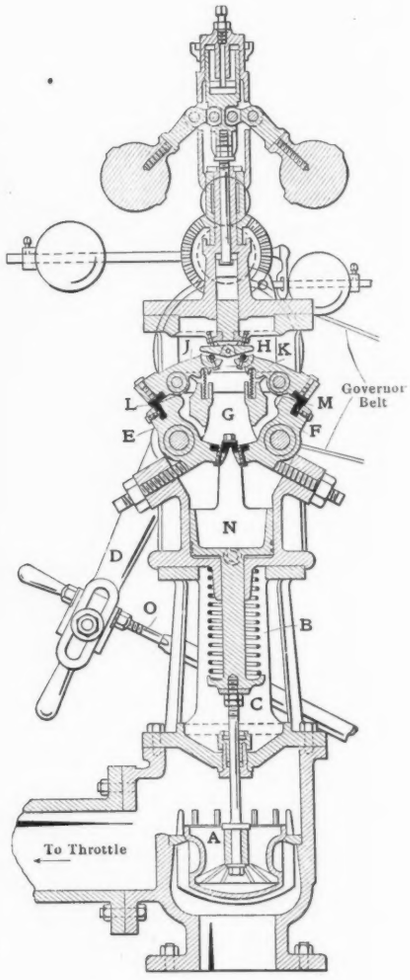


FIG. 2. SECTION OF GOVERNOR

As the governor balls revolve the position of the block *H* is changed, to either higher or lower, and the cut-off regulated by *H* coming in contact with the rolls at the ends of knock-off arms *J* and *K*, forces the inner end down and consequently the outer end up, also alternately. This causes the knock-off blocks *L* and *M* to become disengaged with the block in the rocker-arms *E* and *F*, and thus brings about either a later or earlier cut-off, as the case may be, which will be regulated by the position of *H* and the speed of the engine. When release takes place the spring *B*

forces the valve to its seat, but the dashpot *N* prevents its closing with a shock.

It is evident that considerable adjustment may be obtained by manipulating the arm and changing its position in the slot in the arm *D*. The cut-off can be squared by adjusting the block *H*, while changing the size of the belt pulley will also permit of a still greater variation of speed.

The Government Fuel Investigation and the Smoke Problem*

Statistics collected by the Government indicate that the nation has consumed about seven billion tons of coal up to the present time. Last year the consumption was more than four hundred million tons. During the past ten years nearly as much coal was used as had been used during the preceding century. This increase in the use of coal during the past century has been so great that it is concluded that if the consumption continues to increase at the same rate, the coalfields of this country will be exhausted before the end of the next century. However, if by some means the increase in the use of coal can be checked and the output of the mines kept down to the present figures, there will be no occasion to worry about the coal supply. But the increased demand for coal will probably continue and we may reasonably look for a gradual rise in the price of coal as it becomes more difficult to mine it. Only the best and most profitable seams are being mined at the present time, the inferior coal being left in the ground.

As used at present for heat, light and power, the losses are so great that, of the total heating value of the coal, less than 5 per cent. is converted into useful work in the ordinary manufacturing plant, and even some of the largest and best power plants are able to utilize only about 10 per cent. of the energy in the coal. In railroad operation only from 3 to 5 per cent. of the coal value is realized for pulling the train.

It is estimated that only one-seventh of 1 per cent. of the fuel value is actually converted into light in an incandescent lamp.

Nearly two million horse-power in the form of gas is allowed to escape from the blast furnaces of the country. This condition is rapidly being changed by the installation of gas engines to develop the power.

There is also a great fuel waste in the manufacture of coke, besides the loss of many valuable by-products. It is estimated that these losses amount to fifty million dollars annually.

Believing that the present wasteful methods of utilizing our fuels cannot long continue without serious harm to our country, men prominent in the affairs of the Government, engineers, manufacturers and others have pointed out the necessity of studying the fuels and the methods of utilizing them with the best economy. This has been intrusted to the fuel-testing division of the technologic branch of the Geological Survey. It is a work that covers a wide scope and requires much experimental work extending over a considerable period of time.

It was begun at St. Louis during the exposition in 1904, and has since been continued at St. Louis and Norfolk.

The possible benefits to the Government and to the public resulting from such experiments led the President to appoint a number of prominent engineers, some in the employ of the Government and some as members of the great national engineering societies, to act as an Advisory Board on Fuel and Structural Materials Investigations. Among the organizations represented are: The War Department, the Navy Department, the Treasury Department, the Reclamation Service, the Isthmian Canal Commission, the American Institute of Mining Engineers, the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Architects, and all other leading engineering societies. The board meets occasionally to discuss the nature of the experiments which are most needed, and in a general way the means of conducting them.

The experimental work is done under the direction of the chief of the technologic branch, the details being settled after consultation with engineers who are experts in the particular lines being investigated. A regular force of engineers, chemists and computers carry on the tests as planned and prepare the results for publication.

Purpose of the Investigation

The purposes of the fuel investigations now in progress are as follows: To lessen the waste in the nation's fuel supply; to determine the amount, quality, properties and most efficient methods of utilizing the fuels belonging to the United States, occupying some fifty million acres; the analyzing and testing of coals, using carefully collected samples typical of the various coalfields in the United States, with a view to assembling of data which will serve as a basis of information needed both for the purposes of the Government and those of the general public; to determine means whereby low-grade fuels, bone coal, culm, slack, washery refuse, lignites and peats, heretofore practically unused, may be made of commercial value; the abatement of smoke, with the resultant increased efficiency when burning coal, with all kinds of equipment. The importance of making investigations to secure economy can be better appreciated when we consider the cost of fuel delivered to the furnaces, including all items such as the cost at mines, freight, cartage, handling and firing at the plant, on locomotives, steamships, etc. This figure has been placed at nearly two billion dollars annually for all the coal used in this country.

A saving of only 1 per cent. on the entire fuel bill of the country would amount to nearly twenty million dollars annually.

Results of Fuel Investigations

A study of the fuel values of coals burned while conducting some 540 boiler tests has shown that the value of the coal depends almost entirely on the number of heat units which it contains as determined by a calorimeter, these relative values being influenced somewhat by the amount and character of volatile matter and of ash present in the coal. This information has strengthened the position of the Government engineers who desire to purchase coal on a specification which has for its basis of payment the British thermal units and ash in the coal.

For the coming year a very large part of the coal purchased for the Government will be paid for according to its value as determined in the Government chemical laboratories. One of the largest purchases under this form of contract is for use on the Isthmus of Panama and calls for the delivery of four hundred thousand tons within the year.

Investigations of the washing and coking tests of coals have also shown the possibilities of utilizing poorer grades of coal than are commonly used, and point to a very considerable saving in our fuel supply. The experiments on the briquetting of coal have shown that the slack coal, which is otherwise difficult to utilize, may be made into artificial lumps and used with high efficiency in power plants or for locomotive use.

A study of the furnace conditions in connection with the boiler tests will show the influence of different methods of burning coal with relation to the reduction of smoke. These tests have demonstrated the possibility of burning certain kinds of coal efficiently without smoke in an ordinary furnace. They have pointed to possibilities of modifying furnaces so that practically all fuels may be burned without smoke under favorable conditions. Some bulletins have already been issued on this work, but those which deal directly with the smoke problem are now in course of preparation. The tests made at the producer-gas plant have shown that it is possible to burn almost any grade of coal with the very highest efficiency and absolutely without smoke. Bituminous coals having as high as 45 per cent. of ash, lignites and peats, which are considered low grades of fuel for boiler furnaces, have been very successfully burned in the producer, generating gas for the development of power in a gas engine. The low-

*Paper read at the annual convention of Smoke Inspectors at Cleveland, Ohio, June 24, 1908, by D. T. Randall, engineer in charge of tests at the Geological Survey fuel-testing plant.

grade lignites of North Dakota developed as much power per pound in the gas producer as do the very best West Virginia bituminous coals, when utilized in a steam boiler with a simple non-condensing engine, such as is usually installed in manufacturing plants.

The results of these investigations will have an important bearing on the question of smoke prevention both directly and indirectly, but the Government is investigating the possibilities only from the engineering and not at all from the legal standpoint.

"Elektra" Steam Turbine and Kolb Rotary Condenser

The "Elektra" steam turbine, as described in a recent communication to the Karlsruhe section of *Zeitschrift des Vereines deutscher Ingenieures,* consists, as shown in the accompanying section, Fig. 1, of a wheel upon which the steam is made to act several times. The steam which arrives through the passage *a* is expanded in the nozzle *p* and having passed through the buckets of the turbine is returned through the passages *g*, g_1 and g_2 so that

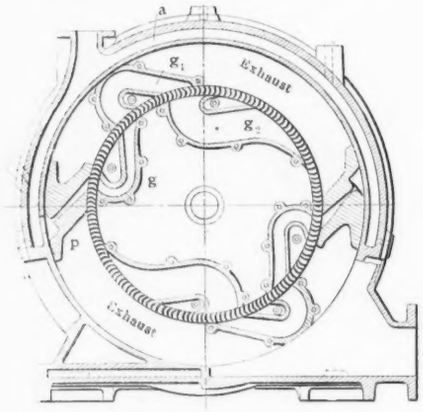


FIG. 1. "ELEKTRA" TURBINE

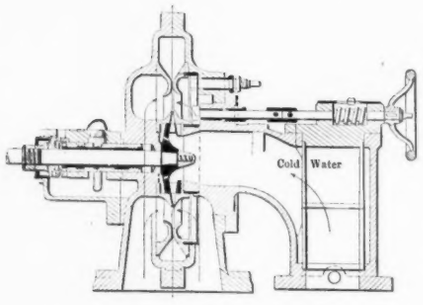


FIG. 2. KOLB ROTARY CONDENSER

it acts successively upon the blades of the same wheel, being discharged eventually into the exhaust passage which is connected with the condenser or to the atmosphere.

The same paper describes the Kolb rotary condenser, shown in Fig. 2. The cold water arriving at the intake shown is taken up by a centrifugal wheel attached to the shaft of the turbine and ejected in the form of a disk, about 1 millimeter in thickness, which is made on both sides by the exhaust steam. The water of condensation, the condensing water and the air are expelled into the annular space surrounding the mixing chamber under a pressure sufficient to overcome the pressure of the atmosphere, or that at which the water must be discharged.

Lightning Protection for Chimneys

BY A. RAUCH

A brick chimney should always be provided with a good lightning rod, intelligently and carefully installed. A steel stack, however, is itself a sufficiently good conductor, and, therefore, does not need

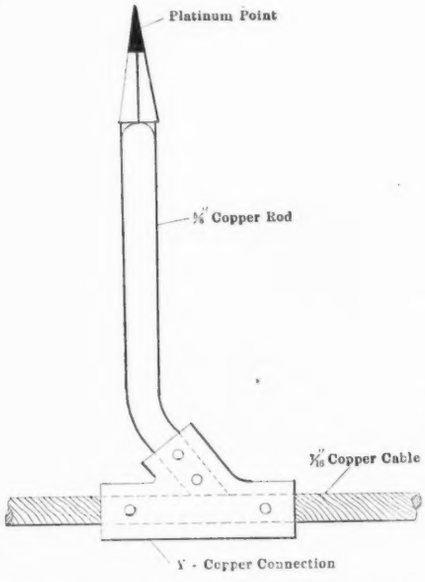


FIG. 1. DETAILS OF POINTS AND CONNECTIONS

lightning rods. So far as personal experience and observation go, I do not know of a steel stack being damaged by lightning.

The expense of equipping a brick chimney with lightning rods amounts to only a few hundred dollars, and this might result in a saving of thousands.

Properly to construct a lightning rod for a chimney, it should be made of a *one-piece* copper cable in order to avoid faulty connections.

The copper cable is fastened to the outside of the chimney with copper clamps and bolts (Fig. 3), the cable running down the side of the stack to a point in the ground below the water level and terminating in a copper plate embedded in coke, as shown in Fig. 2.

The copper cable should encircle the top of the chimney and connect to a number of points at least 3 feet high and equipped with sharp platinum tips. One of these points and its connection to the cable are illustrated in Fig. 1. The cable should be not less than 7/16 inch in diameter, and I prefer to use two 7/16-inch cables in parallel.

A copper cable is better for this purpose than a steel one if it is galvanized, because the life of the copper is very

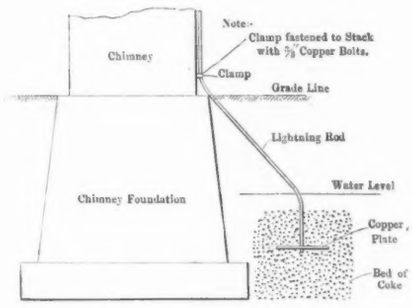


FIG. 2. SECTION SHOWING LIGHTNING ROD TERMINATING AT A COPPER PLATE

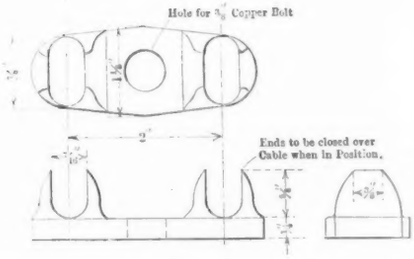


FIG. 3. DETAILS OF COPPER CLAMP USED TO FASTEN CABLE TO STACK

much longer than that of steel cable, which would soon be eaten away by hot gases and unfavorable climatic conditions. Some stacks are equipped with copper ribbon conductors, 2x⅛ inch, and others by 1-inch copper tubes, but I believe the cable is superior because better connections can be made and, better still, it is in one piece, eliminating joints in the main conductor.

Sometimes use is made of water lines at the base of the stack to terminate the cable, or it terminates at an iron bar driven to the water line, but I believe the arrangement here described and illustrated will give better results.

In case the polarity of a dynamo should get reversed, shut down the engine, raise the brushes, close the main switch and gradually cut out all the rheostat resistance. After 15 or 20 seconds, cut all the resistance in again and open the main switch slowly, to prolong the spark. Then put down the brushes and start up. This presupposes that there is another dynamo to supply current meanwhile.

In opening up a boiler be careful that there is neither pressure nor vacuum in it. Do not go by the steam gage, either; open the gage cocks.

The Operation of Electrical Machinery

Classification of Direct-current Generators; How the Connections Are Made; Effects of Residual Magnetism; Three-wire Generators

BY NORMAN G. MEADE

In order to install or operate electrical machinery intelligently, and to select the type of machine best suited to the demands of the service, a fair knowledge of the fundamental principles of that machinery is essential. Hence the elementary discussion here presented is preliminary

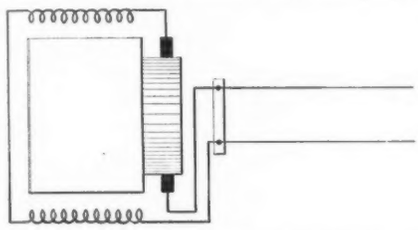


FIG. 1. CONNECTIONS OF A SERIES-WOUND GENERATOR

to a discussion of installation and management.

Direct-current Generators Classified

Direct-current generators are divided into three general classes: series-wound, shunt-wound and compound-wound. In the series-wound generator the whole of the armature current usually flows through the field winding, as indicated by the diagram, Fig. 1. With this arrangement the magnetizing force varies with the current which the machine furnishes to the external circuit; therefore when the armature is running at constant speed its electromotive force varies as the current varies, though not necessarily in the same proportion—in fact, this is not usually desirable, since most applications of direct current require that either the voltage or the current alone be maintained approximately constant. To realize either condition

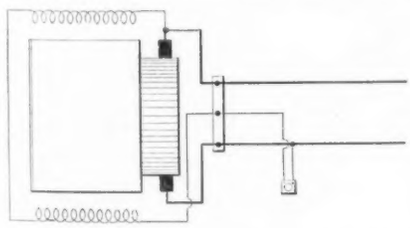


FIG. 2. CONNECTIONS OF A SHUNT-WOUND GENERATOR

in a series-wound generator it is necessary to adopt some method of regulation whereby the electromotive force of the armature may be varied to suit the requirements of service. This is usually accomplished in constant-current dynamos by shifting the brushes from the neutral point, which entails special construction and precautions against sparking.

In a shunt-wound generator the field winding is connected directly to the brushes, in parallel with the external circuit, as shown in the diagram, Fig. 2. The magnetizing current is practically independent of the external circuit, receiving at all times the full difference of potential between the brushes; the changes of current in the external circuit do not affect the magnetizing force acting on the field magnet, therefore, except as they may change the potential between the brushes.

To maintain a constant potential between the brushes under varying conditions of load, assuming that a constant speed is maintained, the magnetizing force of the field winding must be increased

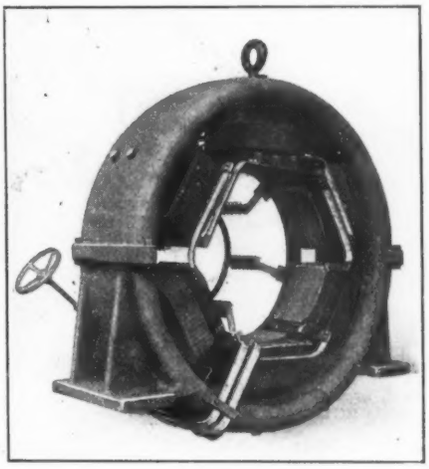


FIG. 3. FIELD MAGNET OF A COMPOUND-WOUND DYNAMO

as the current increases so as to increase the generated voltage just enough to make up for the additional losses incurred. This is accomplished by providing an extra winding connected in series with the armature, similar to the winding of a series-wound machine. This is known as a compound winding, and is shown in Fig. 3; Fig. 4 is an elementary diagram of the circuits. It is evident that the field magnet in this case is provided with a combination of series and shunt windings, the shunt winding furnishing a constant magnetizing force and the series winding an additional magnetizing force which is proportional to the current output of the machine. The series winding is so proportioned that it produces the proper increase in the electromotive force, as the current increases, to make up for the dropping off of voltage that would otherwise occur by reason of resistance losses. For certain work, a little more than this amount is provided, so that the difference of potential between the brushes rises slightly as the current output increases.

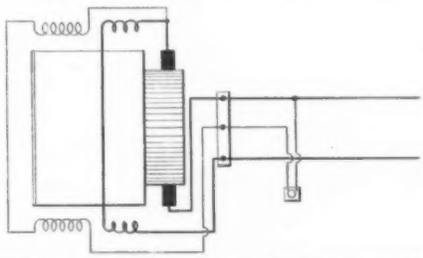


FIG. 4. CONNECTIONS OF "SHORT-SHUNT" COMPOUND-WOUND DYNAMO

Machines thus wound are known as over-compounded generators.

There are two ways in which the shunt winding of a compound-wound machine may be connected; these are the short-shunt connection, Fig. 4, and the long-shunt connection, Fig. 5. With the long-shunt connection the shunt current passes first through the series winding, then through the shunt winding, while with the short-shunt, the shunt current is entirely independent of the series winding, the shunt winding being connected directly across the brushes.

Fig. 6 illustrates a compound-wound machine provided with a series-winding shunt. By varying the resistance of the shunt the influence of the series winding

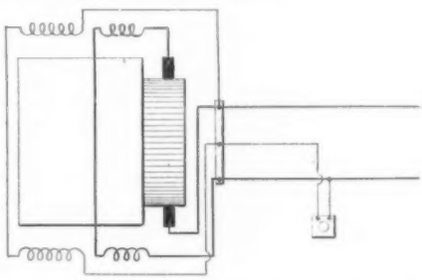


FIG. 5. CONNECTIONS OF "LONG-SHUNT" COMPOUND-WOUND DYNAMO

is varied, and consequently, the degree of compounding.

Effect of Residual Magnetism

In the several types of machine referred to, the iron of the field magnet retains a certain amount of residual mag-

netism after being magnetized; consequently a small electromotive force is generated in the armature winding when the armature is rotated with the outside or work circuit open; this is utilized to start the current in the field winding. In

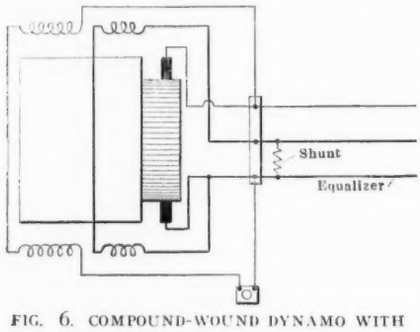


FIG. 6. COMPOUND-WOUND DYNAMO WITH SHUNTED SERIES FIELD WINDING

the case of a shunt-wound generator, when the machine is started and the field circuit closed, the small electromotive force generated in the armature by the residual magnetism sends a small current through the magnetizing coils, producing a small magnetizing force. This magnetizing force adds to the residual magnetism, thereby increasing the electromotive force, which increases the current in the field-magnet coils, still further increasing the electromotive force, and this goes on until the machine reaches its normal voltage.

If the external circuit is closed, only a part of the feeble current produced by the residual magnetism will flow through the magnetizing coils, and the field will build up more slowly; if the resistance of the external circuit is very small, the machine will not build up its voltage at all. From this it follows that a shunt-wound dynamo should be started up with the external circuit open.

A compound-wound generator may be started with the external circuit either open or closed, since it has both series and shunt field windings.

The Interpole Generator

A modification of the ordinary type of direct-current generator is known as the interpole generator, the connections of which are shown in Fig. 7. The construction is essentially the same as that of an ordinary generator with the addition of the small intermediate magnet poles as shown in the drawing. The magnetizing coils of these poles are connected in series with the armature and the regular series field winding, and their strength is therefore proportional to the load the machine is carrying.

To explain more fully the function of the extra poles, which is to insure spark-

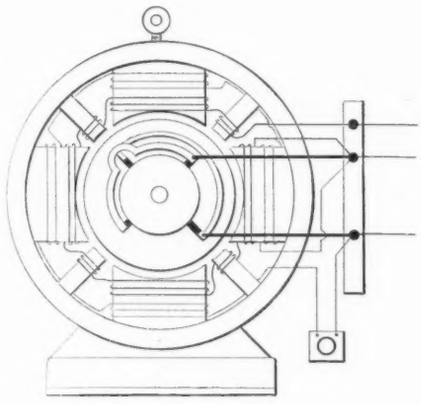


FIG. 7. INTERPOLE DYNAMO

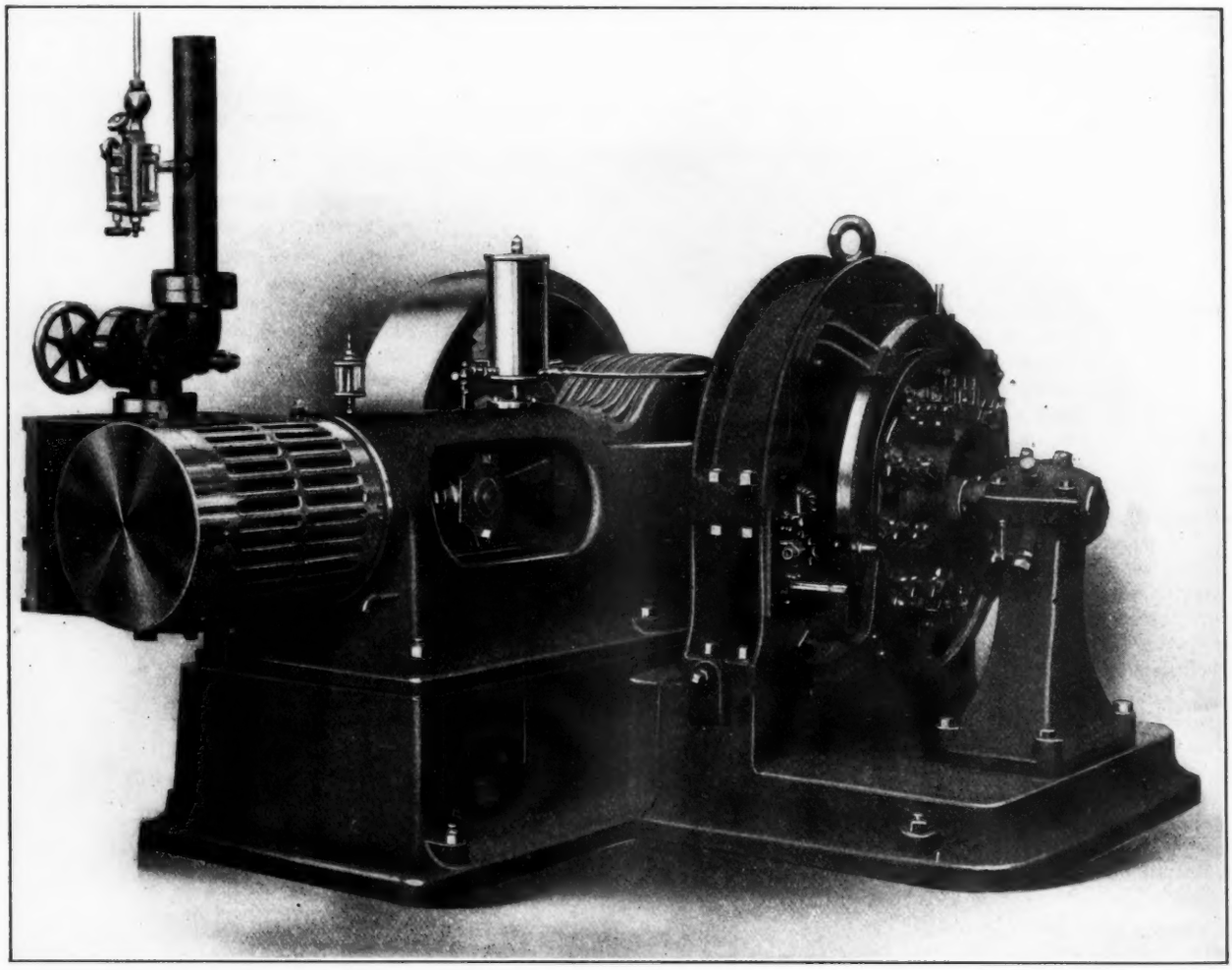


FIG. 8. THOMPSON-RYAN COMPENSATED DYNAMO

less commutation at all loads, it will be necessary to consider the effect of armature reaction. In all dynamos the magnetizing effect of the armature winding opposes that of the field winding and dis-

torts the magnetic field under each pole-face. This shifts the neutral point, necessitating a shifting of the brushes to obtain sparkless commutation. The shifting of the brushes is necessary to bring the coils short-circuited by the brushes under the influence of the distorted magnetic field so that it may generate in them an electromotive force sufficient to reverse the current in the coils the direction in which it should flow when the coils leave the brushes. The purpose of the intermediate poles is to maintain a fixed commutating field so that no adjustment of the brushes is necessary.

The Thompson-Ryan Generator

The Thompson-Ryan generator illustrated in Fig. 8 is of special construction and maintains sparkless commutation from no load to full load without shifting the brushes. Inside the regular ring of field-magnet poles on which are mounted the usual shunt field coils, is a laminated ring slotted somewhat like the stator of an induction motor. In slots in this ring are wound the coils which correspond to the series field coils of the ordinary compound-wound dynamo. These coils are parallel to the armature coils, but the current through them flows in the opposite direction to that in the armature winding; the result is that these series field coils set up a magnetic field exactly opposite to that set up by the armature winding, and as they are connected in series with the armature the current flowing in them is the same as that in the armature and the two fields neutralize each other; consequently the distorting effect of the armature current is neutralized. The result of this is that the field due to the shunt field winding remains stationary and gives a fixed point of commutation.

A portion of the series winding embraces lugs in the laminated ring midway between the main field-magnet poles and produces a commutating field, in the same way as do the intermediate poles of the dynamo in Fig. 6.

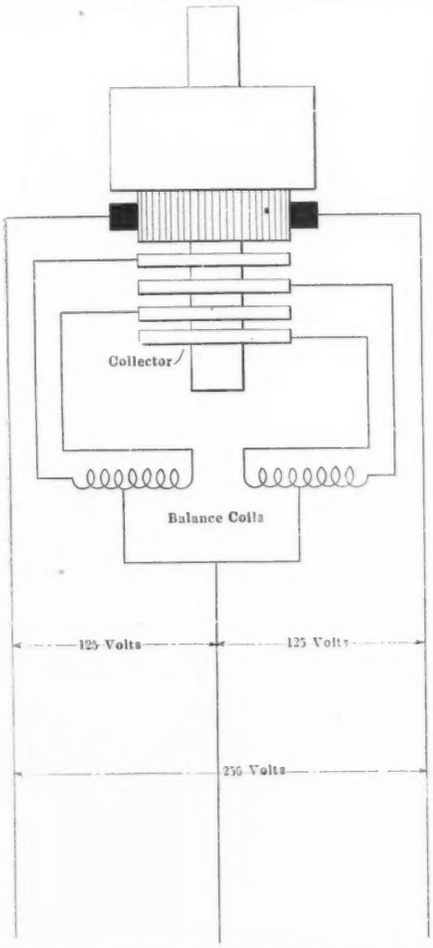


FIG. 9. CONNECTIONS OF THREE-WIRE DYNAMO AND BALANCING COILS

Westinghouse Three-wire Generator

Fig. 9 gives the connections of the Westinghouse three-wire direct-current generator, and Fig. 10 shows the armature of such a machine. This generator is designed to take the place of the two generators ordinarily used to supply a three-wire system. The original arrangement of the three-wire system consisted of two generators connected in series, each delivering current at the voltage of the lamps, and a neutral wire leading out from the connection between the two machines. With this arrangement, both of the two machines must always be in service. This system entails certain disadvantages. The higher first cost and higher cost of operation of two generators, each of half the single capacity of a single generator, is apparent, and the two smaller units require more space in the power house than the single generator. Practically all of the advantages of the three-wire system are retained in the three-wire generator, and there are the additional advantages due to using a single machine instead of two machines of half its capacity.

The three-wire generator differs from the standard, single-voltage, direct-current machine only by the addition of leads from the armature winding which are connected to collector rings mounted on the armature shaft as shown in Fig. 10. This arrangement is exactly similar to that employed for the alternating-current side of the armature of a rotary converter.

Balancing Coils

The connections from the armature to the collector rings may be those of a single-phase, two-phase or three-phase converter, but the two-phase connection is generally used because experience has shown it to give the best results. A pair of balancing coils are connected across the brushes of the collector rings, as shown in Fig. 9. These balancing coils consist each of a single winding encircling a laminated iron core like that of the shell-type transformer, and they are mounted in oil-filled cases similar to that of a standard transformer. The middle points of the balancing coils are interconnected, and from this connection the neutral of the three-wire is led out.

The voltage between the neutral wire and either of the main wires may be easily understood by reference to Fig. 11, which represents diagrammatically the armature winding of a bipolar generator connected to one balancing coil, for the sake of simplicity. The principle is the same in multipolar generators with any number of balancing coils.

Direct-current Brushes

The direct-current brushes are represented by the black blocks at the points *A* and *B*; the balancing coil is permanently and symmetrically connected at the points *C* and *D* of the armature winding, and the neutral wire is connected to the point *E*, exactly in the middle of the balancing coil. The armature winding and connections being symmetrical, it is evident that when the terminals of the balancing coil are directly under the brushes, that is when the point *D* is under the brush *A* and the point *C* is under the brush *B*, the coil is subjected to the full voltage of the generator and the potential between the mid-point *E* and the brush *A*, and that between *E* and *B* is one-half that between *A* and *B*. Correspondingly, when the armature has rotated 90 degrees so that the points *C* and *D* lie directly under the pole centers, the coil is subjected to no difference of potential and the voltages between *E* and *A*, and *E* and *B* are equal respectively to the voltages between *D* and *A*, and *C* and *B*. But since the winding is symmetrical, the voltage between *A* and *D* is equal to that between *B* and *C*;

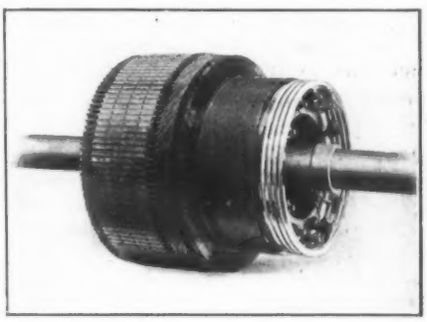


FIG. 10. ARMATURE OF A THREE-WIRE DIRECT-CURRENT GENERATOR

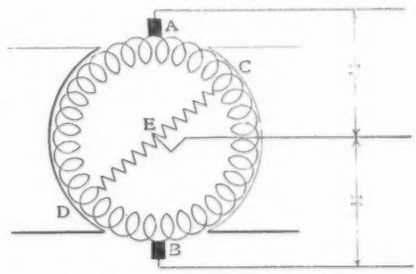


FIG. 11. ELEMENTARY DIAGRAM OF THREE-WIRE ARMATURE AND BALANCING COIL

consequently the voltage between E and A is equal to that between E and B. This holds good in all positions of the armature; the voltage between E and A being the resultant of half the voltage of the transformer coil and that of the armature winding between A and one terminal of the coil.

Since the voltages between A and E and B and E are always equal, it follows that E is the neutral point of the system and may be so used.

Water Power Engineering Principles

By Franklin Van Winkle

There are few, if any, branches of power engineering in which the engineer is called upon to make more interesting application of the laws of natural philosophy, and where those laws can be applied in greater exactness, than in water-power engineering. Every power engineer should be posted on the leading mathematical and physical principles employed in water-power computations, especially when it is taken into account that the fundamental principles and final results are identical with those of computations are, however, less speculative,

The data employed in water-power computations are, however, less speculative, simpler in character and more easily obtained than in other branches of power engineering, so that the subject is more inviting to the practical engineer.

In computing the power developed by a water-wheel, steam engine, or any other prime mover, we resolve foot-pounds of energy exerted in a given time into horse-power. To do this we multiply pounds pressure exerted by distance passed through per minute, in feet, and this product we call foot-pounds of energy exerted per minute. As one horse-power is recognized as a development of energy at the rate of 33,000 foot-pounds per minute, we divide our product of foot-pounds by 33,000 to reduce our computation to horse-power.

Energy Derivable from Falling Water

When any quantity of water descends from one elevation to another, there will be developed the same amount of energy as would be required for lifting that water from the lower to the higher elevation. If W represents the weight in pounds of a given quantity of water and H represents the vertical hight in feet through which that water descends, then the product obtained in multiplying H by W will be the number of foot-pounds of energy developed by W pounds of water descending through the vertical hight H. The total development of energy will be the same whether the water simply drops through the air to be dashed into spray at the foot of a precipice, or part of it strikes the bucket of a water-wheel; or if it descends from one level to another in any other manner.

Under suitable conditions for development, a large part of this energy can be made available for conversion into useful power by building a dam or by the employment of other means for converting the natural flow and fall of the stream into a flow which discharges a given quantity of water per second with a given vertical descent or hydraulic head. Such an enterprise is called a "water-power development."

Power of a Development

The gross power of a development is the product of the weight of water discharged in a unit of time, such as a second or a minute, into the total head; that is, the difference of vertical elevation of the upper surface of the water at the points where the fall in question begins and ends. To express this in symbols, let Q be the flow or volume of water discharged in cubic feet per minute, D the weight of one cubic foot in pounds, or 62.4 pounds nearly, and H the total head in feet. Then $Q \times D \times H =$ the gross power in foot-pounds per minute, which divided by 33,000 gives the gross horse-power.

Example

The developed flow of a stream amounts to 250 cubic feet per minute, and the developed head is 21 feet; what is the gross horse-power developed? Here the quantity Q is 250 cubic feet of water per minute. The weight of water discharged per minute, therefore, amounts to $250 \times 62.4 = 15{,}600$ pounds of water per minute. This weight of water falling 21 feet would develop 15,600 pounds $\times$ 21 feet $= 327{,}600$ foot-pounds per minute. The gross horse-power is, therefore, $327{,}600 \div 33{,}000 = 9.93$ gross horse-power.

The whole of the gross power cannot be made available on account of waste of energy which must be sustained in conversion of the gross energy into useful power.

Part of the head is lost in delivering the water to the water-wheel; part of the energy is wasted by the water-wheel itself and part of the head is lost in creating sufficient fall for carrying the water away from the motor.

Water-power plants are so variable in conditions required for delivering the water to their motors and for getting the water away from the motors that the power actually developed is based upon the effective head employed by the motor.

It must be apparent that with a given quantity of water the most complete utilization of the gross power will be obtained by the employment of a type of motor which can be used to best advantage in utilization of the gross head, (1) by their employment of the greatest possible effective head, and (2) to make the most efficient power development possible out of energy in the water when it is used with the effective gross head.

The second consideration shows us that no matter what type of motor is used it should operate in such manner as to use up as nearly as possible all of the effective head, so that when the water is discharged from the motor, it will be deprived of all head excepting such as may be necessary for carrying the water away from the motor. In practice these requirements are most successfully accomplished by motors which arrest the energy in the water after it has acquired the highest velocity obtainable from the effective head, and discharge the water with the least head and velocity practicable.

My Conversion to Gas Power

By J. C. Miller

I had never taken much stock in gas engines. My previous experience in that line had been with engines of 20 to 30 horse-power, and my memory was good enough to span the lapse of years and bring again to mind the troubles that I had survived.

In those days what joy we had starting a cold gasolene engine. All the operating force took turns in riding the fly-wheel, and one morning, when Pat, the engineer, was thrown violently against a partition, he even rejoiced in his sorrow to know that "she ran." When something did go wrong it was hard to locate the trouble. We had a regular schedule of the points for investigation, and sometimes one thing, sometimes another, caused our woes; never the same thing twice in succession.

In the use of steam as a motive power we could always get some action. Our engineers were not bothered by efficiency tests, and the engine might be using 20 or 100 pounds of steam for all we knew. It was sufficient to know that the engine would run at every demand. Right there is where steam is strong and has made its reputation as a source of power. If there is steam in the boiler the engine will usually run. Economy is a second consideration.

I was destined to have more experience, however, with gas power and it came about this way: The company with which I was connected bought out several Canadian manufacturing plants and in one of them a suction producer and engine of English make furnished the power. Interesting stories came to me from time to time of the economy of this plant and of its reliability, ease of operation and simplicity, so that I was tuned up to look for great things. In the course of time I was called upon to make frequent visits to this factory, preparatory to enlarging it, and the power plant was always a point of special interest and study. The engineer was a Frenchman and knew little of the theory or principles of gas-plant operation. He was a past master, however, of

the art of keeping things in operation as well as of cutting out overtime labor. He came late and left early and his heart was heavy when anything required his attention outside of regular hours. Nothing seemed to surprise him, and even when he looked into the scrubber manhole with a lighted candle in hand, he treated the consequent explosion as something that was bound to occur.

I made it a practice to reach the plant early in the morning to see the starting operations, and I was surprised at their simplicity. The engineer would arrive at 6:40, along with his boy, who manipulated the hand blower. The fire of the day before was poked and the ashes were taken out. Then the doors of the producer were closed, water was turned into the vaporizer, the purge pipe was opened and the boy was set to work on the hand-power fan. The coal hopper had been filled, and we waited for gas. While the fire was being blown up, which took eight or ten minutes, the engineer would attend to his oil cups and was ready to start as soon as gas was coming of the right grade. The gas was tested at repeated intervals from several test cocks by applying a candle thereto, and as soon as a flame could be maintained the engineer would make for the engine. (I had always had some fear as to the safety of a gas plant, but the promiscuous mixing of candles, pipes, gas and engineer soon freed my mind of this.) Compressed air was used for starting. When the engine had partial speed, gas was turned on and the engine would fire. The boy at the fan would be called off and the thing was in operation.

Process of Starting a Revelation

The whole process of starting was a revelation to me, both from its rapidity and positiveness. There seemed to be no question as to whether he was going to make it go or not. It always went, and then the economy of the plant after it was started was amazing. As the engine was of 50 horse-power and used little more than a pound of coal per horse-power-hour, all the attention that was needed was the dumping of two hods of coal into the feed hopper per hour. The "conveyer" was an ordinary coal scuttle combined with the engineer, and he had ample time between conveyings to oversee every operation that took place within seeing distance of the engine. He was not allowed to wander from his post of duty, however, or to do other work.

At shutting-down time the performance was simpler still. The gas supply was shut off, oil cups attended to, purge pipe opened to the air, and the water supply shut off. As the engine used water for cooling from elevated tanks it required no attention in temperate weather. At the end of five minutes the engineer would leave the plant for home.

Learning that other producer plants of English and German make were in operation in the city, I made it a point to study them and see if their performance was as creditable as our own. Such proved to be the case, for all engines were operating satisfactorily and with corresponding economy. Designs differed in detail, but the principles of all were the same, of course, and as a result of this inspection and the record of our own engine I became a convert to producer gas as a source of power.

English builders seem to have about come to a standard in their single-cylinder engine design. There is plenty of weight in their castings; the center line is placed well down toward the foundation; special attention is paid to cooling and lubrication, and there is an absence of small trappy springs and fittings, which sooner or later cause trouble.

It may be added that as a result of our experience with this small engine, a much larger one was ordered and installed as more power was needed.

In conclusion I would urge all power users to forget their early experiences with gas engines, if they have had any, and get next to an up-to-date plant using producer gas. Study it and note the conditions necessary to reliability and economy, and I am confident there will be other converts to gas power.

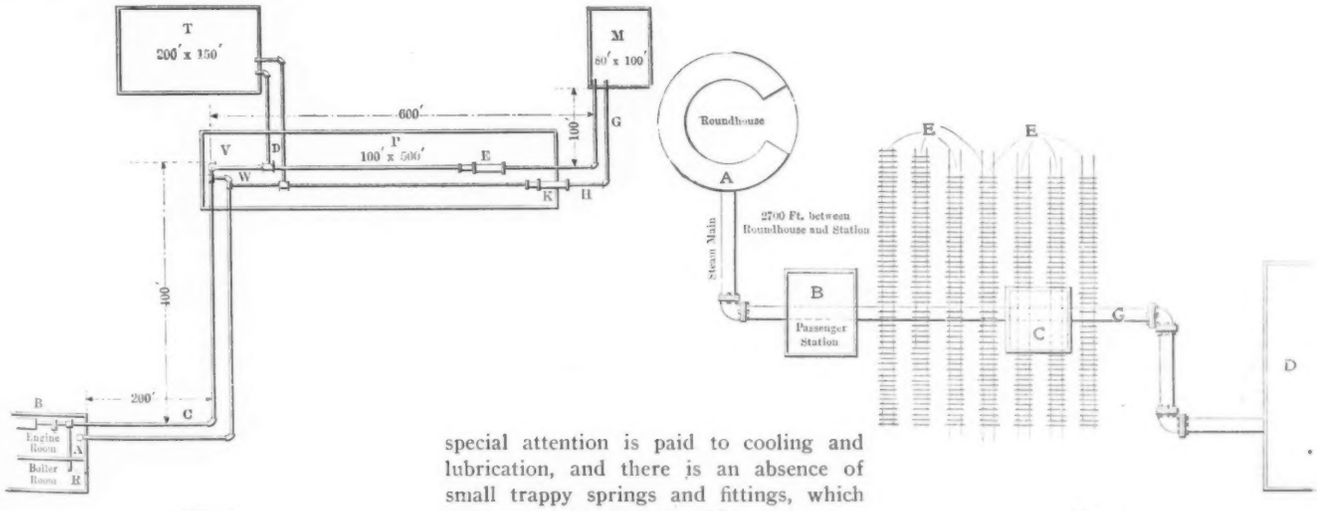


FIG. 1

Installing Heating Mains

By James E. Noble

A description of the method used to run the steam mains for two different and, the writer thinks, unusual heating jobs may be interesting. The work was installed between seven and eight years ago, and both are still in use. In Fig. 1 a 6-inch main is

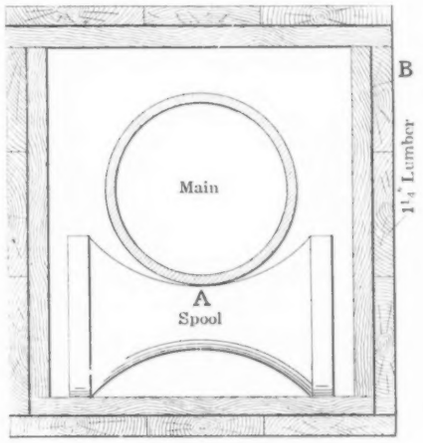


FIG. 2

connected to the engine exhaust and has a run of more than 1300 feet. The building *P* is more than 500 feet long, 100 feet wide and 60 feet high. The building *M* is 50 feet high, 100 feet long and 80 feet wide, and *T* is 200x150x50 feet.

The temperature in midwinter here is often as low as 25 degrees Fahrenheit below zero, and the exhaust from the 125-horse-power Brown engine would heat the buildings without trouble. Of course, there were several hundred men in these buildings, which would help some. The pipe *R* is connected to the live-steam pipe and has a pressure-reducing valve attached which allows live steam to enter the exhaust main whenever the pressure falls below 5 pounds, or when the engine is not running. A steam-pressure gage is also

FIG. 3

attached to the exhaust pipe. The part marked *B* is a separator.

The exhaust main has a fall from the engine of only ½ inch in every 100 feet. A rise of more than 2 feet is given it at *V*, so the pipe will be near the surface, and a ½-inch drip *W* is connected into the 4-inch return pipe. Another drip is connected in the same way at *H*. The return pipe has a fall of ½ inch in every 100 feet toward the receiver *A*, which is emptied automatically by a series of float valves and levers and pumped back into the boiler. Two extra long expansion joints are attached at *E* and *K*, and are firmly anchored. The elbows on the other parts of the main give enough for expansion.

Both mains are laid in a double box, as in Fig. 2. The box is built out of 1¼-inch dry, planed lumber, and a double ply of tarred building paper is placed between the sheeting, as at *B*. The carpenter turned out a number of wooden spools, as at *A*, for a support for the mains and they worked excellently. Where this pipe passes outside, the top of the box is no more than 18 inches below the surface of the ground, but we never had any trouble from frost.

In Fig. 3, at *A* is a high-pressure steam boiler in a railway roundhouse, *B* is the passenger station and offices, about 2700 feet from the boiler, *E* represents car tracks, *G* is the 3-inch steam main used to heat the entire building. The drip is allowed to go to waste. Extra long expansion joints are connected and anchored in the box *C*. The rest of the main is inclosed in 6-inch glazed sewer pipe and all the joints are carefully cemented. In both of these jobs wall coils were used throughout.

A Few Points on Engine Erection

By Thomas W. Hartley

This article is intended to help engineers who are not accustomed to doing erection work, but who are sometimes called upon to erect an additional unit.

In the first place, there is the foundation to prepare. In average dry ground a depth of 3 feet 6 inches below the floor level is ample for engines up to 150 horsepower; above this, the depth will increase in proportion to the size of the engine.

When the excavation is made, 6 inches of sand should be laid in the bottom, and if the ground is any way wet, both the bottom and sides should be waterproofed with tar felt; if the ground is rocky, a 6-inch sand cushion should be filled in around the sides as well, so that the foundation will be well insulated from the rest of building. Next set the templet, and before filling-in imbed the anchor bolts in cement, so that when the concrete is thrown in they will not be disturbed. Also see that there is a piece of pipe around each bolt at least 1 inch larger in diameter than the bolt, as it is sometimes found that there is a little difference between the templet and the engine and this leaves enough leeway generally to overcome this.

Set the engine on the foundation and level it up in position, then put a line through the main bearing to the outboard bearing, so as to get the shaft in line with the engine. Of course, if there is a generator sub-base bolted to the engine frame, this is an easy matter, and about the only thing that needs watching is to see that it is perfectly level.

Everything is now ready to begin grouting, and for this the writer would recommend a mixture of equal parts sand and cement, with just sufficient water to make it barely thin enough to pour, as grouting of this consistency sets very hard. After the grout is set hard, it is a good thing, if possible, to fill in the sub-base of the engine with sand, if there is a sub-base.

The next thing to consider is the piping. As far as possible, bring all the drain-pipe handles in front of the engine under the throttle, where they will be handy in starting and stopping; and if to be piped into the main exhaust be sure to put in a check-valve. In the main steam pipe have as few elbows as you can get along with. Let the pipe have enough fall to the boiler so that the water will drain back, and put in a separator if possible.

Assembling the Parts

When assembling the engine parts, the main thing is to be sure that all the parts are thoroughly clean. Before setting the valves blow out the steam pipes thoroughly while the steam-chest cover is off. If it is a flat-valve engine, put graphite on the cover side of the gasket, so that when it is required to take it off it will not break, but will stick to the steam chest.

Take a look at all of the bearings, then turn the engine over slowly for an hour, and about every ten minutes pump into the cylinder a mixture of graphite and cylinder-oil. A hand pump is usually supplied by the engine builders. The engine can then be put up to speed without fear of the cylinder being cut, unless the piston is too tight. After running light for a short time, the load can be put on gradually until full load is reached. Then the indicator can be put on and valve adjustments made, if necessary. The writer has found by experience that a reducing wheel or gear attached to the indicator is far preferable to the swinging arm or sector so commonly used, as the sector, at the end of each stroke, does not give the same rate of travel to the string as when at the center of stroke. Before taking cards be sure that the piston does not partly cover up the indicator pipe holes, as engines sometimes come out of the shops in this condition, which is doubtless due to oversight.

Attention must now be given to regulation. If the erector has a tachometer this will be easy; if not, the only thing to do is to watch the swing of the ammeter and voltmeter, if it is an electrical unit, as the engine may be within its regulation limit at no load and full load, but by reason of the governor not being sensitive enough it may swing considerably when all the load is thrown off at once, and this will burn out all the lamps in the power house by reason of the engine speed being momentarily too high.

Some Causes of Trouble in Engines

Let us now consider some of the various troubles with engines. First of all, take the common "click" in the cylinder. Frequently this is caused by a ring being too loose, and it can usually be cured by peening the inside of the ring provided it is not too loose. Another click may be in the valve chest, caused by the valve being warped with the heat and thus striking the port edges. This will necessitate scraping the seat and valve. There are a good many causes of pound in an engine, and sometimes the pounds are very difficult to locate. One kind may be caused by the rings being a bad fit in the cylinder thus causing loss of compression; others may be caused by improper valve setting; or by the piston being too tight at one end of the stroke; or by too little compression. A poor-running engine is sometimes the effect of too much compression. In an engine with a balanced valve the latter condition will cause the valve to lift off the seat and slam. A pound can also be caused by the piston traveling part way over the port and on the valve opening the steam will make the piston hammer onto the opposite side of the cylinder.

Before closing, the writer would caution the erector to see that the armature is pressed on the shaft very carefully, if this is done during outside erection, as a bad-fitting key will sometimes spring the shaft. Also note the drop in pressure between the boiler gage and the steam line on the indicator diagram, as this is a good guide as to how much loss there is in the steam pipes and ports due to friction.

A series of reports by the Hydroelectric Power Commission of the Province of Ontario shows that a large saving to the users of heat, light and power can be obtained by utilizing water power instead of coal for these purposes. These reports to the Dominion government were followed by the creation of a commission giving authority, among other things, to expropriate the lands and water rights of power companies when in its opinion it would be for the interests of the people or of a community to do so.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

What Caused the Rotor to Shift?

On page 828 of the May 26 number I note Frank Sawford takes exception to my theory as advanced in reply to the above question, which was originally asked by A. K. S. on page 102 of the January 21 number. Mr. Sawford states that it is inconceivable that sufficient stress could be applied to the rotor to expand the hub from the shaft enough to loosen it. He suggests that if this theory were correct, what would become of the fly-wheel? It is mentioned that in these engine-type alternators the rotor is usually built up of a steel ring fitted to cast-iron arms, while the fly-wheel is wholly of cast iron, and is often much larger in diameter than the rotor.

It would be interesting to know the details of design of the particular rotor to which A. K. S. refers. I am not familiar with the construction of rotor mentioned by Mr. Sawford. According to my observation, the standard alternator revolving field, as built by modern manufacturers, is made up in the following way: The supporting element, commonly called the spider, is of cast iron. This consists of the hub, arms and rim, and up to specially large sizes is cast in one piece. The hub is often cast in open sections, the respective arms or spokes supporting the hub sections. These openings in the hub eliminate any chances of internal strains or rupture, due to possible unequal contractions of the metal in the rim and hub as the casting cools down. The openings are often filled with a metal which expands, rather than contracts, when cooling down after casting, such as type metal, The outside face of the rim is milled with dovetailed grooves parallel to the axis of the rotor. Sectional punchings of electrical sheet steel with corresponding dovetailed ears are then slipped into place and the laminated pole pieces built up. The butt joints between punchings are made to overlap those of adjacent layers by simply displacing each layer of punchings one dovetailed space with reference to the previous layer. The punchings are separated at intervals by ventilating plates. Heavy end plates are provided at both outside surfaces of the built-up laminations so as to prevent their bulging out. Through bolts or rivets are finally inserted, which bind the end plates, ventilating plates and punchings together.

I do not understand to what Mr. Sawford refers by the steel ring unless he means the heavy end plates. Granting that there might be such a steel ring, as he states, is it not conceivable that centrifugal force could cause a tension in the ring that would stretch it? Any such stretch in its peripheral length would cause it to draw the arms and attached-hub sections radially outward. The result would be a looseness of the rotor on the shaft. It is to be understood that the centrifugal force, as assumed, is not sufficient to cause a permanent set or rupture.

As a matter of fact, I at first had the same idea as Mr. Sawford when trying to decide "What Caused the Rotor to Shift," that is, that it was due entirely to a side pull applied to the poles of the rotor, caused by the stationary armature being set out of line. But would that pull, alone, do what it originally took 60 tons per square inch to do when pressing the rotor on the shaft? If so, why has it not repeated its action since the rotor was pressed back to its former place? Would an error of 3 inches in alinement, between the revolving field and the stationary armature be liable to escape the notice of the erecting engineer when setting up the machine?

The construction of standard alternator revolving fields, as described previously, is not claimed to apply to special cases. For instance, in the case of the Manhattan type of engine-driven revolving-field alternator, as built by the Westinghouse company some years ago and operated at the Seventy-fourth street station of the Interborough Rapid Transit Company, of New York City, the mechanical design was a serious problem. In this particular case the revolving field was built as a plate wheel, the rim being supported from the center by steel plates instead of spokes or arms. The diameter of the completed rotor was 32 feet. The rim was of cast iron, dovetailed slots being milled across its face to receive the regular form of electrical sheet-steel punchings. There was no separate engine fly-wheel, as the rotor provided the fly-wheel capacity.

I would gladly accept Mr. Sawford's theory if it seemed to come nearer to answering the particular question asked by A. K. S. In the meantime it would be very interesting to learn of the theories of other readers.

A. V. YOUENS.

Berkeley, Cal.

Repairing an Oil Engine

A few months ago I had a 25-horse-power Hornsby-Akroyd oil engine to overhaul and repair. This is a four-stroke-cycle, center-crank machine and uses kerosene for fuel. Fig. 1 gives an idea of the general form.

The main bearings had worn down until the gears for driving the valve mechanism had bottomed and the engine could not be run. The gears were so badly cut that it was necessary to renew them. It was also claimed that the crank-shaft was sprung, this being judged from the "whop-pity-ding" motion of the fly-wheel on the valve-gear side, and the heating of the bearing on the same side. As the gears were close to the bearing it was easy enough for me to account for the heating, especially after carefully examining the shaft and finding it O. K.

To try the shaft for spring, I took off

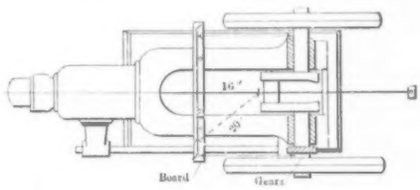


FIG. 1

the bearing caps, placed an accurate level on the shaft and tried both sides of the crank, rotating the shaft so as to get several different positions. The level showed the same in all positions and I decided that the shaft was all right. The wobbly fly-wheel was found to be a loose fit on the shaft and, being keyed on one side, there was nearly 1/16 inch between the hub and shaft near the key. When the wheel was put on after repairs were completed, a sheet-iron shim was put in opposite the key and the "spring" disappeared from the shaft and the wheel ran nearly true. The shaft and wheels weighed about two tons, so a "Triplex" hoist was rigged up over them and a piece of timber run through between the spokes of both wheels so as to bear against the top of the rims, inside, and to this the hoist was attached. A block of wood was then lightly driven in between the crank cheeks, and the shaft and wheels hoisted up and blocked. The old babbitt was then cut out of the bottom halves of the bearing, the wheel on the valve-gear side removed, the old "skew" gear taken off and

a new one put on and the wheel replaced.

The reason for taking off the wheel after it was hoisted up was that it ran in a shallow pit in the concrete floor, which was not wide enough to let it off the shaft. Everything else being in shape it was necessary to get the shaft in position for re-babbitting, so it was lowered until the gears had the desired clearance and was then centered in the bearing and leveled. The next thing was to line it, that is, to get it at right angles to the center line of the engine. The piston was removed and a center line run in the usual manner and fastened to a timber beyond the crank-shaft. The line passed between

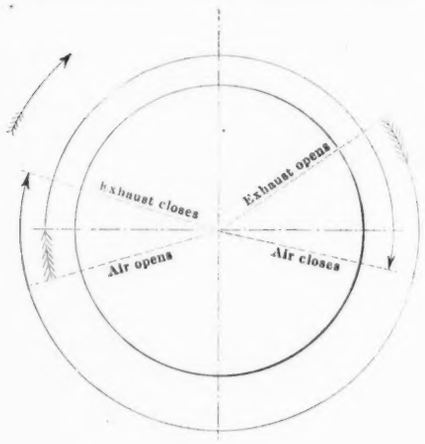


FIG. 2

the crank cheeks and the pin lay just below it; but I was not satisfied with the accuracy of measuring from the line to the crank when the measurements could only be taken with the crank in one position. Therefore, I fastened a piece of board to the frame, between the shaft and cylinder, as indicated in Fig. 1, and stretched a line on this at right angles to the center line. Anyone who has tried it knows that it is difficult accurately to stretch two lines at right angles with the aid of a square, so I used what carpenters call the "six-eight-ten" method.

A triangle having its two sides 6 and 8 feet or inches and its hypotenuse 10 feet or inches forms a perfect right angle. Multiples of these numbers give the same result. For example, 12 — 16 — 20 (feet or inches). Proof: The sum of the squares of the two sides of a right-angle triangle equals the square of the hypotenuse. Now, $6^2 + 8^2 = 36 + 64 = 100$ and $10^2 = 100$. Also, $12^2 + 16^2 = 144 + 256 = 400$ and $20^2 = 400$. The object in using multiples of the first-mentioned numbers is that when inches are used the triangle is small and the accuracy is better if the triangle is made as large as possible. In my case I carefully measured 12 inches on the crosswise line and 16 inches on the center line and marked the points by tying pieces of thread around the lines. The line on the board was then swung until the marks were exactly 20 inches apart and secured in that position. Then by measuring from the cross line to the shaft, outside the bearings, and swinging the shaft until both ends were exactly the same distance from the cross line the shaft was set parallel to the cross line and, of course, at right angles to the center line. The openings around the shaft were then stopped with putty and the babbitt run in, and when the shaft could be turned, the alinement was verified in the usual manner and found to be perfect. So near was the shaft placed to its original position that the bearing caps, which were but little worn, fitted into place nicely without re-babbitting.

As the new gears were without marks for setting, it was necessary to determine their position, and this was done by aid of the diagram shown in Fig. 2. By turning the engine over and noting the opening and closing points of the valves, and timing them as indicated by the diagram, the adjustments were satisfactorily made, and the engine has operated very nicely ever since for driving an electric generator and charging a storage battery.

H. L. STRONG.

So. Portland, Me.

Burning Wood under Boilers

Our boilers, two of them, about 60 inches by 16 feet, of the ordinary tubular

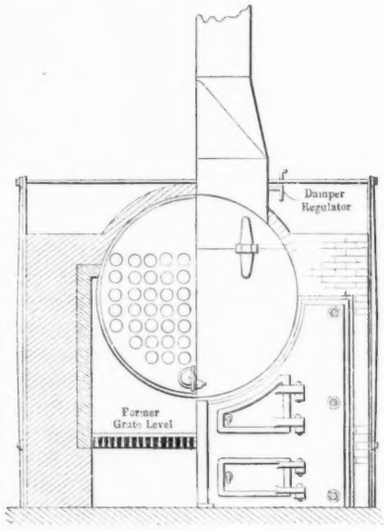


FIG. 1

type, were equipped with rather old-fashioned fronts, as indicated in Fig. 1. The grate was so near the shell of the boiler that in the middle of the furnace there was room for only one layer of logs, the fuel being 4-foot cordwood. This was the seat of most of the trouble, for being thinnest at that point, the fire burned through quickly, requiring constant attention to keep the steam up.

It was finally decided to remodel the furnaces as shown in Figs. 2 and 3. The grates and bearers were removed, the grate level dropped to the floor line and only two 6-inch bars were used, these being placed in the middle as shown in Fig. 2.

With the fire-brick filling we made no attempt to smooth up the rough corners due to battering the courses of brick, but depended on the steep pitch of the furnace walls to roll the logs down to the center as they burned away. The side-wall angle was about 45 degrees and in service proved to be all that could be desired.

The original length of furnace, 4 feet 6

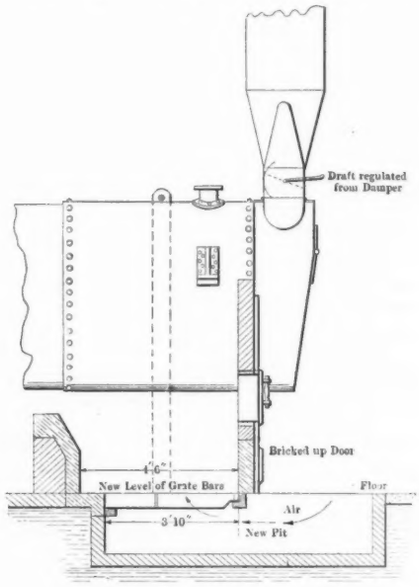


FIG. 3

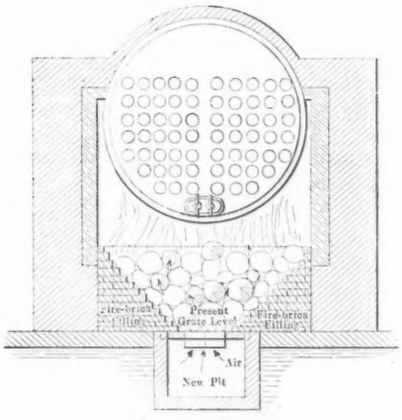


FIG. 2

inches, was retained, but the two grate-bars were cut off to about 3 feet 10 inches, to stop useless cold air from flowing through the furnace.

The front of the new furnaces, that part directly under the fire doors, was fire-brick lined, the old ash-pit doors being sealed up entirely, the narrow trench under the grates serving for the ash-pit and an air inlet.

The draft was governed or regulated

mechanically by working the damper in the base of the stack, the ash-pit opening being left full. These alterations reduced the fuel consumption fully one-quarter, besides saving the fireman a lot of work and bother.

Regarding the claimed advantage of a deep fire-box for burning wood, is it not a fact that the flow of unused cold air through the furnace and setting of steam boilers is the source of a great deal of fuel waste? Regulating the steam pressure by manipulating the ash-pit doors is, I believe, conducive to this same overplus, or useless air trouble. Closing the ash-pit doors will, of course, deaden the fire, but it also sets up another set of conditions that tend to cool off the boiler; that is, closing the ash-pit doors increases the draft in the furnace, thereby increasing the flow of air through the leaky places in the setting above the fire; and as all this air leakage goes in at the temperature of the boiler room, and goes out the stack at or *above* the temperature of the steam in the boiler, a lot of coal is burned just to moderate the weather.

To those who think their boiler settings are practically tight, I will suggest the following easy way to find out if they are: Make a "smoky" fire, say of soft coal, and before the volatile matter has had a chance to get away, close the overhead damper tight, leaving the ash-pit doors *open*. Black smoke will roll *out* through every crack and crevice in the setting. Now, reverse these conditions, open the stack damper and close the ash-pit doors, and cold air will roll *in* through the same cracks and crevices. Ordinarily the conditions under which steam boilers are operated are such that it is impracticable to keep the settings air-tight, for which reason overbalancing the pressure in and outside of the furnace should be avoided as much as possible.

E. G. TILDEN.

Downers Grove, Ill.

Question and Answer Privilege Abused

The editorial in the June 16 number concerning the abuse of the question and answer privilege is timely and to the point, but does not go far enough. The copying of questions from various textbooks is bad enough, but was it ever noticed that writers sometimes ask for help with their correspondence-school work? It would seem hardly possible that a man would stoop to such a thing, but having been through a course with the I. C. S., I have noticed several times that correspondents asked questions that seemed rather familiar, one set in particular, not in POWER AND THE ENGINEER, recalling some work which I had had difficulty with. I resurrected the old question papers and there, word for word, were five or six questions which someone had asked to have answered.

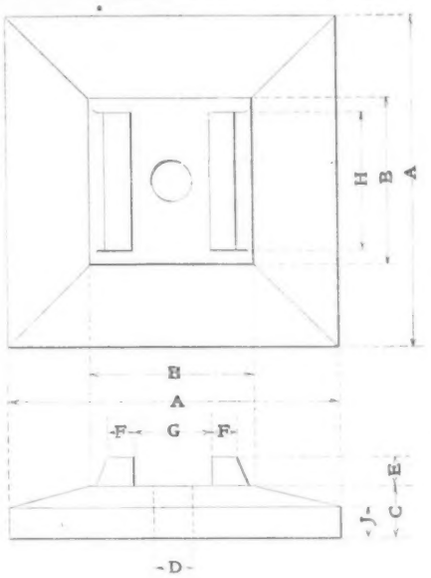
Another editorial in the same issue refers to some questions given to the members of the N. A. S. E., on indicator work. Will it not be possible to print those questions in an early issue and let some of us, who like mental exercise, have a chance at them? Or, if preferable, let those who wish, answer them, the best solutions to be printed.

HARRY H. YATES.

Trenton, N. J.

Foundation Washers

The accompanying is from a blueprint giving the details of my standard foundation washers. The writer has used this style of washer in a number of power plants and they have proved very satisfactory.



Dimensions									
Size	A	B	C	D	E	F	G	H	J
⅝″	6″	3″	1″	3/16″	½″	⅛″	1½″	2½″	½″
¾″	6″	3″	1″	3/16″	⅝″	⅛″	1¾″	2½″	⅝″
⅞″	8″	4″	1″	1/4″	⅝″	⅛″	2″	3½″	⅝″
1″	8″	4″	1″	1/4″	¾″	⅛″	2¼″	3½″	½″
1¼″	10″	5″	1¼″	1/4″	¾″	⅛″	2¾″	4¾″	¾″
1½ & 1¾″	12″	6″	1½″	1/4″	1″	⅛″	3¾″	5½″	¾″
2″ & 2¼″	15″	8″	2″	5/16″	1¼″	⅛″	4½″	7½″	1¼″
2½″	18″	9″	2″	5/16″	1½″	⅛″	4¾″	8½″	1¼″
2¾″	24″	12″	2½″	3″	1½″	⅛″	5″	11½″	1½″
3″	24″	12″	2½″	3/16″	1½″	⅛″	5⅛″	11½″	1½″

DETAILS OF FOUNDATION WASHER

These washers are made of cast iron and, having allowed plenty of room around the bolt and also the head, there is absolutely no finish required on them. The recess in the head is designed to take an unfinished, hot-pressed square nut. The dimensions of these nuts are given in the Carnegie Steel Company's hand-book. They are known as "manufacturers' standard," not the "Franklin Institute standard."

These washers are designed so as to give them sufficient bearing surface on the concrete so they will not crack it, should the bolt be screwed up too tightly. They will not injure the concrete, even with sufficient tension on the bolt to break it.

In designing foundations, the writer finds it to be of great advantage to make pockets around the washers, so that in the case of a bolt breaking, another one can be put into place with very little trouble, without having to break away the concrete and rebuild it again, as in the old style of imbedding the washer in the concrete. These pockets should be at least 12 inches wide on the smaller washers, and on washers 12 inches square and over, they should be at least two inches wider than the washers. When the bolt is within two feet of the edge of the concrete the pocket should only be 12 inches deep, but shoudl the bolt be farther in, it should be at least 18 inches wide and 24 inches deep, so that a man can crawl into it, in order to adjust the washer and nut.

In one of the plants that I was connected with, we could not obtain pipe readily to place around the bolts, so we built wooden boxes instead. The writer suggested that they place the boxes in water and let them soak for two or three days before placing them in the forms, to allow them to be thoroughly saturated with water. They did not do so, but placed them in dry, and consequently when the foundations had been in about a week they commenced to crack, due to the boxes swelling, thereby causing an internal strain sufficient to overcome the strength of the fresh concrete. By wetting the boxes thoroughly beforehand it will eliminate this danger entirely.

F. HARVEY SEARIGHT.

San Francisco, Cal.

Reducing Engine Performance to Standard Conditions

In the June 9 number, on page 915, under the head of "Reducing Engine Performance to Standard Conditions," Edward C. Perry, Jr., asks readers to advise as to how to go about making corrections for vacuum when the barometer stood at 20 inches and the mercury showed a 19-inch vacuum. In this connection I would say that it has been my practice to correct for vacuum in the following manner, which in a way corresponds to the method which is numbered (2) in his article:

Barometer = 20 inches;

Vacuum = 19 inches;

Weight, in cubic inches, of mercury at 60 degrees Fahrenheit = 0.49.

So we proceed as follows:

$$20 \times 0.49 = 9.80;$$

$$20 - 19 = 1;$$

$$1/20 \times 9.80 = 0.49$$

pound per square inch.

For instance, we will assume the standard conditions in which the barometer is reckoned at 30 inches (sea level). We will say the vacuum is 29 inches and note the results:

$$30 \times 0.49 = 14.70;$$
$$30 - 29 = 1;$$
$$1/30 \times 14.70 = 0.49$$

pound per square inch.

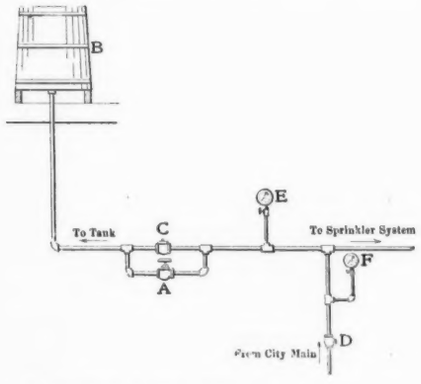
So it is plain, then, that 30 inches barometer and 29 inches vacuum is the same as the 20-inch vacuum and 19-inch barometer.

G. E. WEARN.

Philadelphia, Penn.

Steam Gage Puzzles

A steam gage on a hoisting-engine boiler once did a mysterious stunt. The running pressure was 80 pounds and the safety valve was set to blow at 90 pounds, but one day the gage showed more than 100 pounds pressure. At first it was thought that the safety valve had stuck, so we proceeded to cool the boiler. But the pressure went down too slowly. I had suspicions about the gage and let a little water out of the pet-cock. To my surprise it then registered the true pressure of the boiler, 70 pounds. A small valve from which a pipe went through the smoke bonnet on the side of the boiler opposite the steam gage had become "choked down" (a bad practice) to prevent excessive vibrations of the gage pointer. The disk in the small valve was loose enough on the stem to let it act as a small check, and the hot gases in the smoke bonnet



HOW THE GAGES WERE CONNECTED UP

generated the excessive pressure in the small pipe.

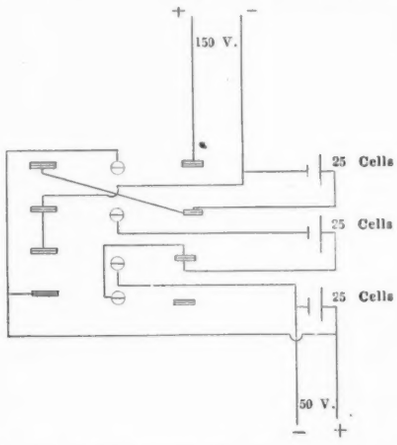
Another time two gages connected to the same tank and with city pressure registered widely differently. Referring to the sketch, the check-valve *C* permitted the city pressure to remain on the sprinkler system without overflowing the tank *B*; and the check *D* prevented the water from the system from returning to the mains. The by-pass valve *A* was opened, filling the tank *B*, when both gages remained at 40 pounds. Next morning the gage *E* showed 65 pounds and *F* only 40 pounds.

CHARLES HAEUSSER.

Albany, N. Y.

Solution of Problem in Storage Battery Connections

To solve Mr. Lincoln's problem in the May 5 number, on page 710, one four-pole double-throw switch is used. I have used the sign of a single cell



MR. CERNY'S SOLUTION OF PROBLEM IN STORAGE-BATTERY CONNECTIONS

to represent each group of twenty-five. Throwing in the switch to the right puts the cells in series for charging and leaves the lighting circuit connected to twenty-five of the cells. Closing the switch to the left connects groups of twenty-five in multiple across the lighting circuit.

FRANK W. CERNY.

Mesa, Arizona.

Can an Indicator Detect Leaks?

In the May 19 number, E. A. Campbell says, among other things: "If the actual curve falls below the theoretical, you may depend on it that the piston or exhaust valve is leaking; if the curve of the diagram comes above the theoretical expansion line we may be positive that the steam valve is leaking." This is not always the case. An absolutely correct curve, if it were possible to secure one in actual practice, does not necessarily show an economical engine, for the simple reason that a defective leakage may be the same on both sides of the piston—one balancing the other—and the indicator would never detect it. The surest way of determining this is by blowing through the cylinder cocks.

If Mr. Campbell's theory were correct the indicator would show a leak every time, either in the piston or exhaust valve, or in the steam valve, for in every case the actual or true expansion curve will be either above or below the theoretical, depending upon conditions under which engine is operating, and in case of a perfect condition of valves and piston, the curves will cross at some point in the stroke.

The true expansion curve will fall below the theoretical during the first stages of expansion, as at *A* in the accompanying diagram, due to the condensation of the steam upon entering the cylinder, causing the pressure to fall more rapidly than that due to expansion. This condensation will continue until a point is reached where the temperature of the steam will equal the temperature of the cylinder, when it will be re-evaporated, raising the pressure sufficiently to cause the true expansion curve to cross over the theoretical and continue above it, as at *B*, until release takes place.

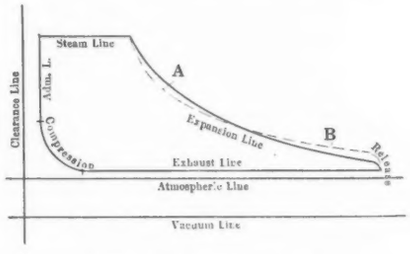
J. L. BRADSHAW.

Memphis, Tenn.

In the June 16 number I notice several letters on the question, "Can an Indicator Detect Leaks?" The letters all follow the textbooks' treatment of the subject pretty closely, and would probably be good answers to a license examiner's question, but for a man who is asking for practical advice, I think the answers tend to give him a false confidence in the infallibility of the indicators.

Let us take the case of an old engine that is in bad shape and probably leaking all around. A leaking admission valve will tend to keep up the expansion line; a leaking exhaust valve, or piston, will tend to lower the line; on the return stroke the leaking exhaust valve or piston will tend to lower the compression line and cause a hook, while the leaking admission valve will tend to offset this result.

Now I will admit that this set of conditions (a leakage both into and out of



EFFECT OF CONDENSATION

the cylinder) will not produce a true adiabatic curve, nor does an engine that is not leaking do so either. I think that the man who can take such a card and make the proper allowances for initial condensation, re-evaporation and the different leakages, has no business to pull on a pair of overalls every morning; he ought to be a consulting engineer. I will frankly confess that when I test an engine for leakage, I pull off the cylinder-head, block the fly-wheel and then turn on the steam to find the leaks.

I have owned and used an indicator for years—long enough to realize its limitations—and I think for the ordinary operating engineer its value may be sized up about as follows:

1. It is invaluable for correct valve setting.

2. If care is used, it is reliable for obtaining the horse-power developed.

3. It may at times be of some value in detecting leakage.

4. It is almost useless in calculating steam consumption.

A. L. HOYLE.

Philadelphia, Penn.

Setting Slide Valves to Run Under

I read with interest the article by P. E. Merriam in THE ENGINEER for March 16, and that by A. L. Mertrud, page 663 of the April 28 number, on valve setting, and I have used a method similar, but I think, for an emergency, much simpler, as follows: Place the engine on either dead center, open the cylinder cock on that end, slightly crack the throttle valve, turn the eccentric until the steam escapes from the cock, and secure the eccentric. To reverse the engine, do as above, turn the eccentric until the steam again escapes from the cock, secure it and the engine is reversed. Be sure that the eccentric leads the crank, in the direction you wish to run, and check up with the indicator when you have an opportunity.

R. ROWLAND.

St. Elmo, Colo.

A quick method to set a slide-valve engine to run backward without removing the steam-chest cover, is to place the crank on the crank-end center, make a center punch mark on the valve-stem stuffing-box, and then make another mark on the valve-stem about 6 inches from the first mark. Take a tram and adjust it so that the points will set in the center-punch mark on the stuffing-box and the one on the valve-stem. Slack up on the eccentric set-screw and pull the eccentric backward until the tram points come into the center punch marks. Then fasten the eccentric and the engine will run under. I have done this several times with a slide-valve engine, but the indicator would give finer adjustments.

Concerning Earl E. Webster's question on belt lacing, I would say that the leather lace is much better than the wire lace. As a rule the wire lace doesn't last long; the bending on the pulley breaks it, just as a piece of wire in the fingers would break, if bent back and forth. A glued belt is better than either, and especially for generators.

ALBERT SMITH.

Barrytown, N. Y.

The articles under the head of "Setting Slide Valves for Running Under" have interested me very much, that is, the variety and elaborate detail of the methods employed by the different writers is of unusual interest, for I cannot understand why such a simple subject should be treated so fully. For instance, the last article in the June 9 number by Charles J. Mason, in which he criticizes at length the methods of other writers, and then concludes by telling us about angles and degrees. While his method is correct, it is not a very convenient one to use in actual practice.

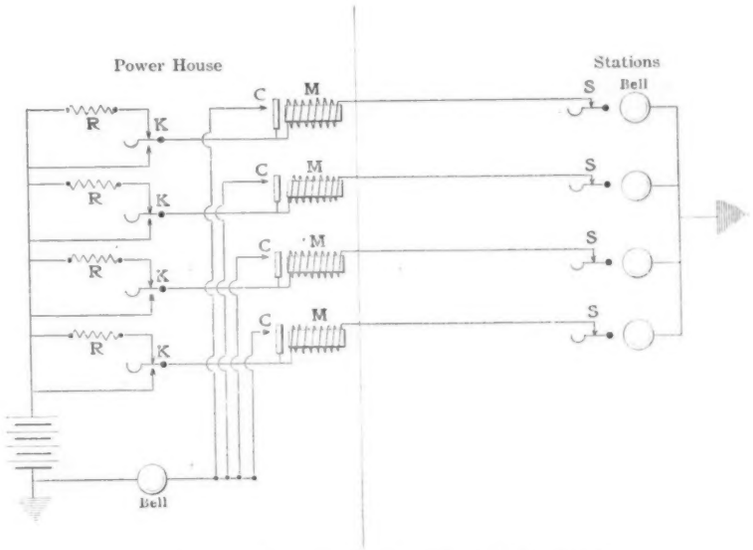
The following is my method: Simply place the engine on any one of the dead centers, make a mark on the valve-stem even with the face of the stuffing-box gland, then loosen the eccentric and move it around on the shaft in any old direction at all until the mark on the valve-stem again comes even with the face of the stuffing-box gland. If the valve was properly set for running over, you can wager all you are worth that it will be properly set for running under.

FRANK KNAPS.

New Orleans, La.

Solution of Wiring Problem

As a solution of Mr. Harrison's wiring problem in the May 19 number the accompanying circuit is submitted. As indicated in the sketch, the system is normally on closed circuit. The current from battery passes through the four relay magnets *M* and the corresponding lines to the outlying stations in parallel. Each resistance *R* is such as to permit just sufficient current in its line to energize the relay magnet *M*, but not enough to ring the bell at the outlying station. The power house can signal each sub-station by cutting out the corresponding resistance by the proper switch *K*. Each sub-station can signal the power house by opening the circuit at the switch *S*; this will release the relay and allow its armature to drop and make contact at *C*, thereby ringing the power-house bell by closing the local circuit through one of the resistances *R*. A number on the face of each relay armature will indicate the station that is calling.



MR. FISCHER'S SOLUTION OF "A WIRING PROBLEM"

HARRISON FISCHER.

Brooklyn, N. Y.

How should Gas be Metered and Charged For?

On page 503 of the March 31 number a correspondent asked for information on the above subject. A few years ago, in the Indiana natural gas field, a glass company was taking gas from an 8-inch main with a 13-inch lead to the meter and a 2½-inch pipe from the meter to the boilers. Now the company is using a meter, and the gas is charged for just the same as before. Daniel Chittenden, in the April 28 number, page 63, says gas expands a certain per cent., and that per cent. of expansion is what the meter does not register. Now, then, will gas in a compressed state go through a meter and register as it should and expand and make another meter register more gas under this expansion pressure than the meter would register under pressure before expansion occurred?

This argument was put up to the gas company and they claimed it would; so a meter was set in the 2½-inch line and daily readings by the gas company on meter No. 2 proved a saving of $20 for the glass company for fuel consumed.

I have been using gas for twelve years and know from actual experience that a gas meter will register more gas under pressure than actually passes through the meter. For instance, if the pressure exceeds 22 pounds, the meter will register more gas than it will at eight pounds,

both pressures having the same volume of gas from different-sized pipes. Therefore, after the gas has been allowed to expand the speed through the pipe and the second meter is not so great, but the volume is the same as it would be if compressed in the smaller pipe.

Natural gas confined under pressure in a 1½-inch pipe will make no more heat units by transferring it to a 2-inch pipe until after it has been mixed with air. If burned out of either size of pipe and mixed with the proper amount of air both pipes should develop the same amount of heat units.

If I were the correspondent first mentioned, I would try and get the gas company to explain how that $55 gets by the meter and not register. It would be different if he were making a pressure between the meter and his boilers to exceed the pressure in the main line, for then the gas company would be right to charge for running the meter backward.

If Mr. Chittenden were using steam by meter would he be willing to pay for the expansion from a 1½-inch pipe to a 2-inch pipe, under the theory that it would make more power after expansion, before he had got the work out of it for his use, than it would in the compressed state? This would be as fair as his theory of gas expansion, as I think gas and steam come under the same head when work from either one is considered.

G. W. Felver.

Muncie, Ind.

Finding Average Values of Round Gage Charts

Let me submit a criticism to the method in Power and The Engineer of May 12, 1908, of finding average values of round-gage charts, by Mr. Hoppin. I cannot see how accurate results can be obtained from such a method, and even if approximate results are obtained they have a very uncertain percentage of error. I submit a Bristol chart and a curve. The chart was for an ammeter and not a pressure gage, but the principle is the same. If you observe the chart closely you will see that the spacing is not at all uniform; that is, from the zero circle to 25 is by no means one-half of the distance from zero circle to 50. This accounts for the large curvature in the curve submitted. My method of plotting the curve was as follows: The pressure is constant all the way around the 25-hundredth ampere circle and I obtained the area of the space between the zero circle and the 25 circle. This I did with all the circles and plotted the amperes the long way of the paper and the areas of the space between each circle and the zero circle the other way.

Now consider the chart. The area *A B C D* has an area of 5.08 square inches. This on our curve corresponds to 72.5-hundredths amperes. But by observation we see that the curve had been at 200-hundredths amperes for 4 hours and 0 ampere for 20 hours. Then average amperage is

$$\frac{200.4 + 20.0}{24} = 33.33 \textit{ hundredths}$$

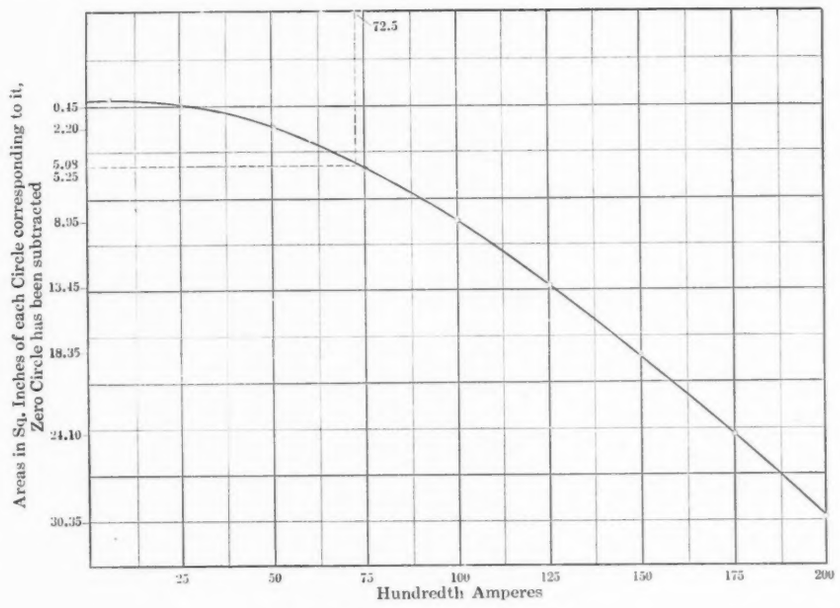
amperes, and the 72.5-hundredths amperes must be incorrect.

My only explanation of the inaccuracy is that Mr. Hoppin has assumed every curve traced on a chart as a whole circle.

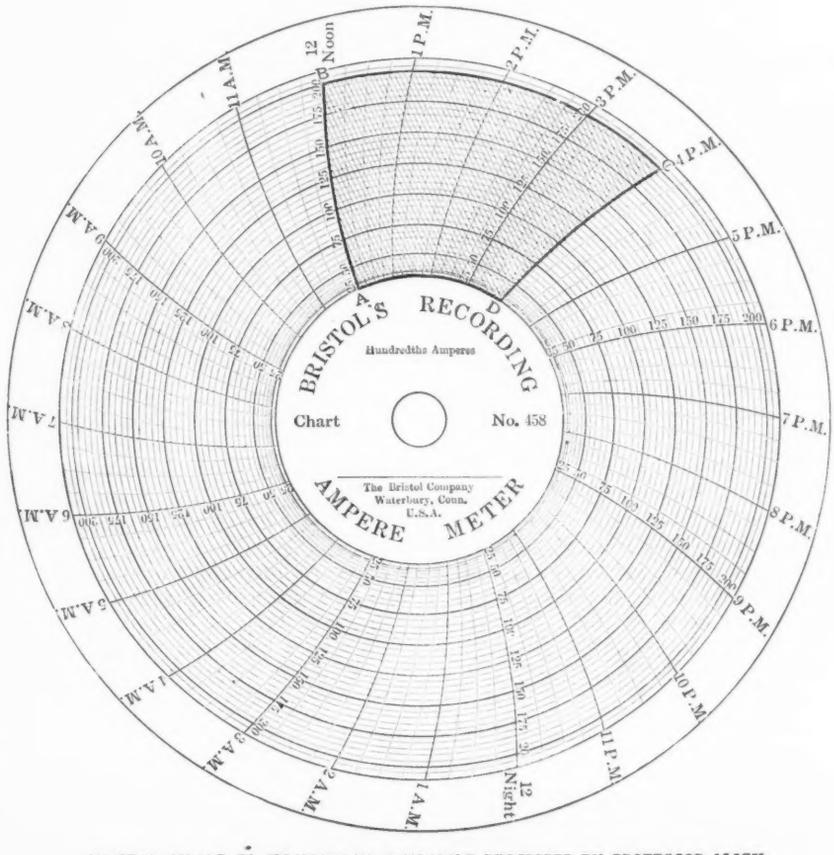
This is incorrect, as some of the jagged curves are far from circles. The nearer one approaches a circle the closer will the result obtained from the curve plotted approach the accurate result; but this is very uncertain to have to estimate your error each time.

G. A. Glick.

Madison, Wis.



CURVE PLOTTED BY PROFESSOR GLICK



BRISTOL CHART TO ILLUSTRATE PRINCIPLE DESCRIBED BY PROFESSOR GLICK

Why Not Let the Engine Pull the Chain?

In the June 2 number, Mr. Sawford says that he fails to see what advantage the "simplicity engine stop" has over the ordinary stop-valve. Mr. Sawford probably never saw an engine run away from the failure of an automatic device, nor does he know that boilers are burned and exploded by putting too much dependence in automatic boiler feeds.

In more than twenty years' power-plant experience I have learned that there is positive danger from imaginary safety, and I will not place my faith in any automatic device to keep out of trouble. That is one reason why I believe the engine should not be depended upon to pull the chain.

The "simplicity engine stop" does not depend upon electric or centrifugal force or springs and weights to operate, and only requires just a little grit applied by the right place and the right time by the engineer to cut off the steam instantly and with comparative safety, by a pull on the chain, the emergency valve usually being at one side or away from the fly-wheel.

It is not practicable to use the ordinary valve in this position for this purpose without the improvements, or a butterfly valve, in a steam line with 150 pounds of steam back of it.

The emergency valve can be used as an ordinary valve if repairs are to be made to the steam line or it is necessary to get into the cylinder. There must be some difference, for the United States patent office issued a patent on the four improvements.

An attentive engineer and this valve are far more reliable in my opinion than any automatic engine stop upon the market, or an intelligent fireman is more trustworthy than any automatic boiler feed ever invented, for he must necessarily attend to business, and that is just what is required on high-pressure boilers and high-speed engines.

A simple gas-pipe extension would reach the jack-screw from the floor by which, with one hand, the valve is unseated against the steam pressure, while holding down on the chain with the other to prevent its opening too quickly. As there are several things liable to happen to an engine besides running away, I would ask Mr. Sawford of what use is any automatic device if the engine should become disabled or if the boilers should prime and send over a few big slugs of water. Would he just let her go, or would it be wise to wait for the engine to pull the chain?

I would never permit the drilling of a 13/16-inch hole for a 1-inch pipe tap in the fly-wheel of a high-speed engine or any other, nor would I wait until the speed was great enough to move a little brass plug out from centrifugal force before there was anything doing.

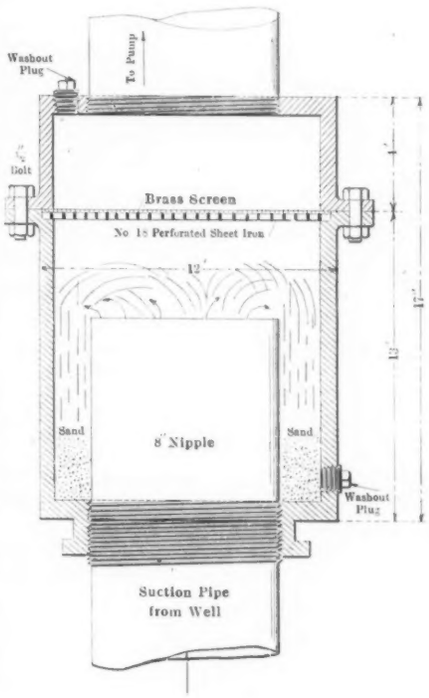
W. D. RANNEY.

Columbus, Ohio.

Driving a 36-Foot Well

A recent letter on "Driving a 36-Foot Well" interested me, and I think I can improve on Mr. Pearce's method of cleaning out the pipe and on his sand separator.

After the pipe is driven down to the water a smaller size pipe, say ½-inch, is lowered inside of the driven pipe and connected up to some water supply with a hose until it touches bottom. The water will flow from the bottom of the driven pipe to the surface and carry all the sand



A SAND TRAP

and mud up with it, without the necessity of connecting a pump.

After the pipe is all clear and the water stops overflowing (if the passage through the perforated point is clear, the water from the hose will flow just as readily out of the pipe into the ground as it will flow into the pipe from the ground, providing you are in water-bearing strata), I put on a sand trap and connect it with the pump and everything is done.

In this case the sand does not go through the pump and cut the cylinder, but is held back by the screen in the trap. Whenever the trap is filled with sand to a hight of the nipple in the trap, it has to be washed out with a hose, by taking out the washout plugs, or by disconnecting the trap. If it is not cleaned out the sand will fall back into the point.

The trap consists of a circular vessel, preferably cast iron, about 12 inches in diameter by 17 inches in hight, made in two sections bolted together; a perforated round sheet of No. 18 iron is placed between the two sections and above that is put the brass-wire screen. The sheet iron is merely put there to stiffen the screen. The 8-inch nipple is screwed in lightly from the inside before it is bolted together.

R. SCHREIBER.

Albuquerque, N. Mex.

Belt Lacing.

Replying to the request of Mr. Webster, in the June 9 number, page 912, regarding wire and leather belt lacing, my experience with both may be of interest.

Anyone using the wire lacing, properly applied, will never resort to the use of whang or leather lacing for several reasons.

Very few men can lace a narrow belt with leather and have it look neat or stand a severe strain for any length of time; and a governor belt should never be laced with anything but wire, in my opinion, because in punching the ends of a belt for the leather lacing it is necessary to punch from ⅛- to ¼-inch holes about ½ inch from each end, which destroys the most important part of the belt by disturbing the layers of leather, if it is a double belt, weakening it and practically making two joints where it is joined together.

There is a machine made for lacing belts using a coil spring of soft wire which is rolled into each end near the edge and only requires flattening, being joined together by a ⅛- or ¼-inch round roll of hard hawhide, which makes a very neat and substantial joint, flexible at the joint only.

A 6-inch double belt used on a planer for planing locomotive frames, and a 5-inch double belt on a large locomotive-wheel lathe, where a severe and intermittent pull is required, will last three or four times longer with wire lacing than the best whang, however carefully applied.

I have taken apart a whang-laced belt and laced it with wire, as explained, between the ends and the large holes punched for leather, and I have never had the wire joint fail. It would invariably break where the large holes were punched for the leather lacing.

The wire will not stretch like the leather lacing and oil will not affect it, but will stay put longer than leather, besides being safer and you have no ends to dispose of.

There may be some objection to the wire lacing on wood-working machinery, where the speed of the belts is high, or because of the noise of the joints passing over the pulleys, but for general machine-

shop work and governor belts the wire lacing is the best.

W. D. RANNEY.

Columbus, Ohio.

In the June 9 number, page 912, I am interested in the question of Earl E. Webster's in regard to wire and leather laces. I am employed in a foundry where I have occasion to notice the difference between belts laced with leather and those laced with wire. The wire lacing was constantly pulling out the holes of the belt, making it necessary to cut off the ends. The belt was used on a motor. There is also a large leather-laced belt used to run an iron cinder-washing machine. The lacing causes but very little trouble. Wire lacing cannot be pulled up as as even and smooth as leather lacing, and the joints are more or less rough. It would be my advice to use leather laces.

J. E. STROTHER.

St. Joseph, Mo.

Preventing Clicking of Piston Rings

About a year ago I had trouble with the piston-packing rings in a small engine clicking considerably, as if they were striking the bottom of the seat. It was a 12x12, running at 300 revolutions per minute, direct-connected to a generator. The piston was fitted with two snap-rings ½ inch square. I procured two ordinary clock-springs, ½ inch wide, and corrugating them as shown in the sketch, slipped them around the piston under the rings, and the trouble disappeared.

SHOWING HOW CLOCK SPRING WAS CORRUGATED

J. L. BRADSHAW.

Memphis, Tenn.

What Is to Prevent the Use of the Drift Pin?

I used to think that the Massachusetts law regulating the construction of boilers was a little hard on the builders, and that raising the factor of safety on all boilers, over a certain age, of the lap-seam type would cause a hardship to those who chanced to be operating such boilers.

We had two boilers which came under the law as to age and construction. The insurance company notified us that after a certain date the pressure would have to come down from 80 to 50 pounds per square inch, so our manager ordered two new boilers of the quadruple-riveted butt-joint type and pulled out the old ones. The first one out I examined carefully, and could not find a blemish. It looked to be in condition to carry 80 pounds for several years.

With the chief's permission I cut nine rivets from the longitudinal seam and the holes and the rivets indicated a very liberal use of the drift pin. If the drift pin was used in the past what is to prevent its use now? And how is it to be known if it has been used, without pulling the boiler apart?

A. GRISWOLD.

Adams, Mass.

Misleading Reports

Reading the letter by H. N. Hadfield, in the June 9 number, entitled "Misleading Reports," brings to my mind the old but very common mistake of the average newspaper reporter when he gives an account of an accidental death by electricity. The accounts usually read: "15,000 volts of electricity passed through his body," or words to that effect. Now why cannot these reporters learn that there is no such thing as "volts of electricity"? I once wrote to the editor of a newspaper calling his attention to this and explaining at some length the proper terms to use, but about two days afterward there was an account of a lineman being killed by having touched a wire carrying "2000 volts of electricity." My letter apparently did not do much good.

It would be so easy for them to say the lineman touched a line carrying a potential, electromotive force or pressure of 2000 volts.

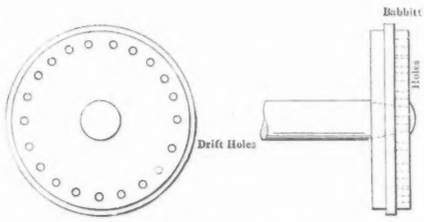
J. E. BATES.

Spirit Lake, Idaho.

Pistons

In the general run of experience of the average engineer I think there is no piece of machinery which needs more care and receives less than the piston. This part of the engine, I am sorry to say, is often run on the hit-and-miss principle, both as regards care and lubrication. The first thing to be considered is perfect lubrication. There are almost as many different types of piston as engines. Years ago, when engines were in a more crude form, the piston consisted of a simple plunger packed as follows: A number of common-sized rope yarns were obtained and a gasket braided as firmly as possible, tapering for about 18 inches at each end, and long enough to go around the piston and overlap the length of the taper. The rope was coiled around the piston the narrow, or thin way, and beaten down with a mallet and plug until it fitted the cylinder. Some melted tallow was then poured in and another layer of packing put in with the necessary tallow until the depth of 5 or 6 inches was obtained, always finishing with a liberal dose of tallow, after which the follower-plate was screwed down. When the engine was just started an abundance of tallow had to be used, owing to the excessive friction, gradually decreasing as the cylinder became smooth. It is needless to say that this crude method demanded continuous watchfulness and care, both as regards lubrication and keeping it in order. A later date of piston, and one in which metallic packing is first mentioned, was the adoption of a single split ring with a tongue and groove to break the joint. The edge of this ring was ground or filed away in order to allow of packing with the usual hemp and tallow behind it, the ring being supposed to carry the weight and take care of the wear and the hemp and tallow to make it steam-tight.

The next improvement or advancement was the adoption of a babbitted piston. In this case the piston was made solid and turned to a nice sliding fit in the cylinder. A good, deep recess was also turned around the circumference, holes being drilled at rather close intervals around the face of the piston and connecting with the bottom of the recess. Babbitt was then poured in until the recess was full. It was then cooled off and turned to fit the cylinder pretty tight. It very speedily wore itself to a fit.



A BABBITTED PISTON

When these pistons became too loose the adjustment was made by means of a drift-pin used in the holes in the face of the piston. By driving on this pin the babbitt was forced out to the walls of the cylinders. Good judgment had to be used in the operation, both as regards keeping the piston central and also as regards drifting it out too much, thereby making it too tight and causing undue friction and loss of power.

The next advancement was the split-ring variety, in which the piston was made solid and a split ring introduced in the center with a lap joint. Gradually more rings were introduced as different engines were made, and also an expansion ring to keep the outside rings tight to the wall of the cylinder. Then the sectional variety became popular. This consisted of a number of sections dovetailed into each other, thereby making a complete circle. They were held in place by circular springs underneath which extended all

around underneath the sections, thereby keeping them steam-tight. I believe these are in use quite successfully in a more or less degree at the present time. It is safe to assume, however, that the old-time engineer, with his crude method of lubrication, had to be more constant in his attention to his business than are a good many engineers of the present time, who are blessed with modern machinery and automatic methods of lubrication.

CHARLES H. TAYLOR.

Bridgeport, Conn.

Current Consumption of Induction Motors

What L. A. Thompson reports on page 997 of the June 23 number in regard to the centrifugal circulating pump, is clearly a case of throttling the discharge due to part of the condenser tubes being obstructed with shellfish, etc. This choking up of the tubes increases the friction of the water passing through the unobstructed tubes and consequently increases the velocity of the water and the resistance and total head.

As the pump is operated by a constant-speed induction motor, and the increased head is accompanied by a falling off in pump capacity greater than the increase in head, the amperage drops under the condition Mr. Thompson cites as a matter of course. This can perhaps be best expressed by saying that by far the greater part of the peripheral speed of the impeller is required to raise the water against the head. After this is accomplished a comparatively small increase of peripheral velocity (or revolutions per minute) will give the desired flow; so it will be readily understood that the difference in velocity required between circulating water into a slight vacuum and delivering it against a pressure of four pounds will mean a considerable falling off in pump capacity.

Mr. Thompson does not mention what the vacuum conditions are at his turbine under the variations at the circulating pump. If the vacuum is equally as good under both conditions, with like loads and temperatures of circulating water, it looks as though the condenser and circulating pump are rather too large for the turbine.

E. F. DOTY.

Camden, N. J.

Mr. Thompson states that when operating with the turbine under full load, the motor requires but 20 amperes, whereas if they open all of the drips with the turbine idle, the motor will take about 35 amperes. The reason for this is simply the amount of air being handled. With the turbine under full load, the amount of air is comparatively small, and the load on the motor is, therefore, comparatively small, whereas with all the drips open, the amount of air to be handled is increased materially, and, therefore, the work done is increased, and the current consumption is correspondingly increased.

In the case of the motor handling the circulating pump, the same holds true. The amount of water handled by the circulating pump when all the condenser tubes are free, is considerably greater than when the tubes are plugged. The total water lifted and moved is the measure of the work done by the motor; and since with the tubes free from obstruction the amount of water to be lifted and moved is greater, the power required to do this will also be greater.

Mr. Thompson can easily test this by putting a valve on the discharge, running the valve wide open and then gradually close it until he has finally closed the valve entirely, and no power will be consumed by the motor beyond that required at no load, plus the power required to churn the water in the pump.

HENRY D. JACKSON.

Boston, Mass.

Wear of Wrist Pin Brasses

In a recent number, on page 541, Joshua L. Bichell places himself on record

FIG. 1

as claiming that the wrist-pin brasses of an engine wear faster than those of the crank-pin; and to back up his assertion he says that he has an engine on which he keys up the wrist-pin 84 times as often as he does the crank-pin. There is no doubt in my mind that he will find the

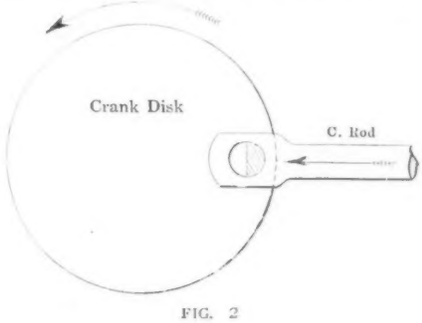


FIG. 2

cause of this difference in wear to be due to a difference in the babbitt metal of the two boxes.

With a given metal, lubrication, attention, etc., there seems to me no reason for the wrist-pin boxes wearing the faster, but on the contrary, every reason for the crank-pin boxes getting the most wear, when one considers that the former travels or, rather, turns so much less than the latter per revolution. If Mr. Bichell is right in his contention that a rock-shaft wears faster with a small motion than with a greater, then the theory and practice of the prony brake must need a lot of fixing.

There is certainly more wear on the crank-pin than on the wrist-pin, for the reason that most of the wear comes on *one* side of a crank-pin, as will be seen by referring to Figs. 1 and 2 herewith.

As will be seen, the shaded half of the crank-pin gets the *most* of the wear, but not *all*, of course. On the other hand the wrist-pin gets the pressure, and consequently the wear, on alternate sides each revolution.

Although Mr. Bichell thinks all the engine builders wrong in making the wrist-pin and brasses smaller than the crank-pin and its brasses. I am of the opinion that they know what they are doing, and *why*.

J. A. CARRUTHERS.

Bankhead, Ont.

Lubricator Trouble

We are running two triple-expansion engines, 20 and 56 by 36, and 34 and 56 by 36, or about those sizes, and we have a closed tank in the pit below the engines for the cylinder oil, taking the water pressure from the main steam line, connecting it at the bottom of the oil tank. A pipe is connected at the top of the tank, which leads the oil to the cylinders, with a sight-feed glass attached. On the high-pressure cylinder the oil feeds in above the throttle, or between the boilers and the throttle, which gives the same pressure behind and ahead of the oil and lets the oil work by the difference of gravity in oil and water. It works well, but the trouble is in the intermediate and low-pressure cylinders; they will work only a few minutes.

I think the trouble is in the unequal steam pressure, as we have almost to close the feed valve to make it feed slowly enough, which soon clogs the valve and stops the feed. I think we should have a separate tank for each cylinder and take the water head from the same place the oil is supposed to enter. I think that if Mr. Lawson will connect his lubricator between the throttle and separator, and leave the top connected as it is, he will have no more trouble.

J. E. ESTES.

Ponemah, Ill.

If Mr. Lawson will clean his lubricator thoroughly this will remove the trouble. Sometimes scale from the pipe connection finds its way into the lubricator and clogs up the passages.

GUS. A. JANICKE.

Louisville, Ky.

In a recent number H. B. Lawson shows a sketch of his lubricator connec-

tions for a duplex steam-driven air compressor, and claims that his lubricators will not feed regularly. I think his whole trouble lies in the difference of steam pressure, at the point where the upper connection is taken from the main and the point where the lubricators are connected to the steam pipe. If instead of having the lubricator connections below the governor and throttle he will place them above, I think his trouble will cease and one lubricator will do the work instead of two.

With the lubricators feeding in between the governor valve and the steam chest, with the pressure in this part of the line varying according to the demand for steam by the compressor, the lubricators cannot work properly. When the demand for steam is light the pressure in this part of the line will be light and the lubricators will feed fast, and as the demand for steam increases the pressure will rise and the lubricators will feed slowly. I would advise him to put a steam gage on where one of the lubricators is and note the pressure with the compressor running. I think he will find that it will vary, and in this case the lubricators cannot feed regularly.

By placing both connections above the governor and throttling, the steam pressure will always be the same at both connections, and if good oil is used they cannot fail to work properly.

N. S. CAMPBELL.

Detroit, Mich.

A Short Circuit on a Trolley Line

Joseph Bonnet's article under the above title, on page 791 of a recent number, reminded me of an occurrence at the West Madison street car barns in Chicago about three years ago. A green motorman was trying to run a car into the barn, and in turning from the main line onto the switch he ran his car entirely too fast, with the result that when the trolley pole flew off the wire it hit the switch wire with so much force that it broke it in two, a section of it falling over the front of the car, burning out everything it touched.

It was just getting dusk and I never saw such fireworks in my life. The trouble continued for at least two or three minutes before anything was done, then a lot of conductors and motormen got alongside the car and pushed it back, and in so doing knocked loose another section of trolley wire, one end of which fell across a rail and about 10 or 15 feet of the wire flashed up and exploded like a cannon. For a wonder no one was hurt, and the arrival of the trouble-wagon crew saved further blunders.

Apparently from the looks of things in the neighborhood of the burned car, someone "had hung a monkey wrench on the safety valve" of the power-house circuit-breaker, for there certainly were two grounds in this case, as well as in the one cited by Mr. Bonnet.

ETHAN VIALL.

Decatur, Ill.

Gas Engine Trouble Caused by the Producer

A large gas-engine plant contained several engines that had been in operation for a considerable time, running without difficulty and giving satisfaction. The igniters were changed regularly once a week, the engines were opened up, looked over and generally overhauled every other week. One day an engine that had been entirely cleaned out and fixed up in the usual way the day before commenced back-firing; all possible changes of the mixing valve failed to overcome the difficulty, so another engine was started in its place, while a third engine on the line continued in operation without trouble. Soon after the substitute engine had been started, the engine that had been running all right commenced acting in the same manner as the first; it would back-fire, lose its speed, almost stop, then start off again and run for half an hour all right and then again go on the same kind of rampage, while another engine using the same gas continued to run without difficulty. This continued with all of the engines in turn, until late in the afternoon, when all of them had to be stopped and the trouble hunted down and corrected.

The igniters were removed and found coated with carbon, but not stuck. The head removed from the inside cylinder of the first engine showed nearly a pint of carbon dust and grit; openings along the gas line back to the dry scrubber showed deposits of dust. Examination of the dry scrubber showed it to be hot, and the wet scrubber was examined for the cause of the trouble. The overflow pipe showed the usual amount of water running and the pump delivering water to the sprinkler in the top of the wet scrubber was running at the usual speed. One side of the wet scrubber was cold as usual, but the other side was so hot it could hardly be touched with the hand. Upon opening the space where the sprinklers are located it was found that the openings or perforations in the bell-shaped sprinkler were entirely stopped up around more than half of its circumference, and the increased pressure at the others forced the water through them with so much force that nearly all the water went to the shell of the producer and ran down the side instead of sprinkling the baffling material and keeping it wet and cold enough to clean and cool the gas.

The hot gas soon dried out all the moisture from the baffling material, carried all its own dirt from the producer through the scrubber, and also gathered more from the coke in the scrubber. The volume of gas necessary to supply the engines, increased by the expansion due to its high temperature, soon formed passages through the dry scrubber sufficiently large to carry its impurities with it, so the hot gas loaded with these impurities deposited them in the piping and combustion chambers. A portion of the deposits remained in the engine cylinders after each explosion until the accumulation was sufficient to remain incandescent; then it ignited the fresh mixture, causing back-firing or premature explosions.

Had the producer operator been attentive to his duties he would have discovered that his gas was running hot before the actual trouble occurred. His test flame would have shown sufficient difference from the normal condition to attract attention, and his vacuum and pressure gages would have shown a change in their variations. The occasional feeling of the outside of the producer and scrubber shells by the operator as he walks around the plant will often attract his attention to any abnormal condition. The sprinkler in the wet scrubber should be given periodical examination and cleaning, and never be left unwatched and uncleaned until clogged or stopped.

T. F. CHRISTOPHER.

Philadelphia, Penn.

Scale in Boilers

P. G. Jones' article, in a recent number, on "Scale in Boilers," is amusing, to say the least, especially that section in regard to using Smooth-On to patch up a worn-out flue-sheet.

I would think if the flue-sheet were "worn out," and the flues so weak that they cannot be expanded properly and safely, the best thing to do is to have a new sheet and flues put in, or consign the boiler to the junk pile.

J. L. BRADSHAW.

Memphis, Tenn.

Some Motor Troubles

H. A. Jahnke's idea in a recent number, in regard to "Some Motor Troubles," is correct. I was recently called into a plant to assist the engineer in locating the trouble where the motor was working under exactly similar conditions. My first suggestion to him was to install a countershaft to relieve the motor of its load when starting up. This was done and no trouble was experienced afterward.

If the total load of all the machines driven by the line-shaft does not require a great per cent. of the output of the motor, it will work very well without the countershaft; but if the load is heavy, the installation of the countershaft is almost a necessity.

J. L. BRADSHAW.

Memphis, Tenn.

Convention of the International Association for the Prevention of Smoke

It was apparent at the third annual Anti-Smoke convention held at Cleveland, Ohio, June 24, 25 and 26, that the suppression of smoke was becoming of the greatest interest and importance to the cities of the United States.

Many interesting papers were read, showing that much careful thought had been given to the subject by those directly interested in the work in the various cities.

A pleasing incident of the opening exercises, which took place in the assembly room of the Hollenden hotel, was the presentation of a box of beautiful cut flowers to Paul P. Bird, of Chicago, with the best wishes of the members of the association, the occasion being Mr. Bird's recent marriage.

At 2:30 p.m. on Wednesday, the members met at Case School of Applied Science, where they listened to a paper on "Chemistry of Combustion," by C. F. Maberry, professor of chemistry at Case School, and a paper on "Fuels of the United States," by N. W. Lord, professor of metallurgy, Ohio State University, and chief chemist of the United States Geological Survey.

A paper on "Fuel and Boiler Room Economics," by Prof. C. H. Benjamin, was, in the absence of the author, read by H. W. Woodward. In the evening, members and friends attended the Euclid Avenue Garden theater in a body.

A delightful automobile ride through Cleveland's parks and boulevard system opened the Thursday morning session. The ride ended at the consolidated mills of the American Steel and Wire Company, where the manufacture of steel wire was followed from the raw to the finished product, the many processes in its manufacture proving very interesting to the visitors.

From the steel plant the party proceeded to the Country Auto Club, on the lake shore, where a magnificent dinner was served, after which the company was entertained by vocal solos rendered by Miss Beatrice McCue, and violin selections by Miss Leonora Krause.

Several hours were spent amid the beautiful surroundings of the auto club before returning to headquarters at the Hollenden.

At 8 p.m. the legal and mechanical session of the convention was opened in the auditorium of the Chamber of Commerce.

W. E. Mook, of Cleveland, read a scholarly paper on the legal aspect of the smoke nuisance. Mr. Mook has had much experience along these lines and was well qualified to address the meeting on this subject.

Paul P. Bird, chief smoke inspector for the city of Chicago, then read a paper on "City Supervision of New Boiler Plants." This paper was based on the large experience Chicago has had in combating the smoke evil.

Robert H. Kuss, assistant smoke inspector of Chicago, followed with an interesting discussion on Mr. Bird's paper.

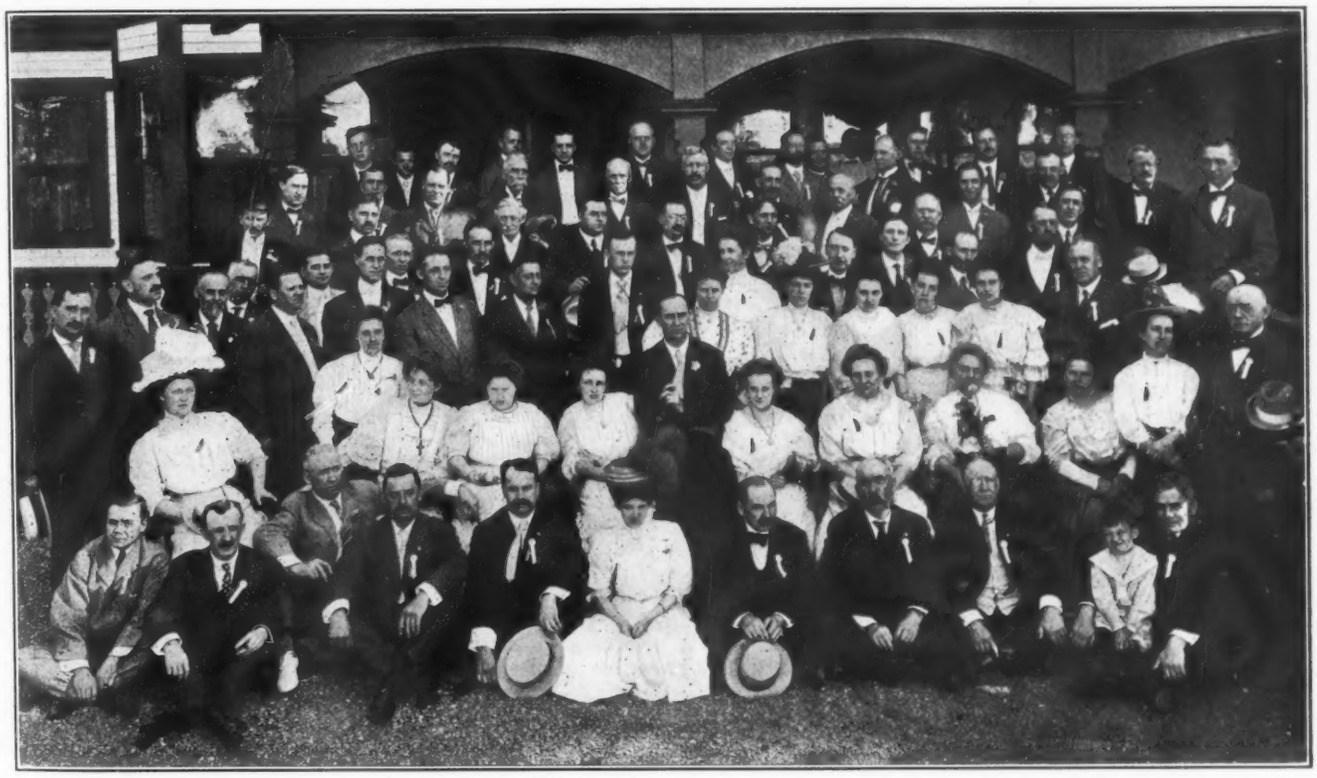
"Steam Jets" was the subject of a paper by A. W. Puddington, of Cleveland. The author, who is a deep student of the subject of combustion, is the originator of a system of steam jets as applied to boiler furnaces, and he treated the subject in a very thorough manner.

Friday morning, at the final session of the convention, P. L. Cobb, of Columbus, read a paper on "Central Stations for Power and Heating." This was followed by an interesting account of experiments on air-cleansing apparatus as applied to round-houses, by W. E. Taylor, of Toledo.

D. C. Walmslee, of Indianapolis, read a paper on "Stationary Plants," and Prof. D. T. Randall, engineer in charge of fuel tests of the Geological Survey, talked on the relation of the government fuel investigations to the smoke problem.

A lecture on mechanical stokers, by H. W. Woodward, of Cleveland, illustrated with lantern slides, was an interesting feature of this session. Mr. Woodward took up the different types of stoker, showed typical installations of each type and enumerated the advantages claimed for each.

John Krause, of Cleveland, whose subject was "Railroad Smoke," gave an account of the experience of the city of Cleveland with this form of smoke nuisance. During the discussion which followed, many valuable points were brought out regarding this phase of the subject.



ATTENDANTS AT CONVENTION OF INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE, CLEVELAND, OHIO, JUNE 24, 25 AND 26

Syracuse, N. Y., was chosen as the place of next meeting, and the officers elected for the following year were: John Krause, president; O. T. Higgins, of Syracuse, vice-president, and R. C. Harris, of Toronto, secretary-treasurer, Mr. Harris being re-elected.

Three Typical Gas Producer "Troubles" and Their Causes

By F. C. Tryon

A certain producer-gas plant not located "down in Maine," had been operated by the erecting superintendent for about a month after the plant was regularly accepted and each day the engineer, who was to have charge and care for it after the erecting man left, was regularly drilled in the various manipulations and told what was the proper thing to do in each case, in all kinds of emergencies. He was coached and checked in starting up in the morning; he was told what service each separate part of the producer plant was expected to perform, why it was required and the results that might be expected if its particular share of the work was neglected. Each day when anything peculiar would happen the erecting man would call this operating man's attention to the occurrence, show him what he had done to correct the difficulty and explain the probable cause of it, telling him what to look out for and what action to take.

This particular producer had several steam jets opening into the fire-bed on the line where the most intense heat of combustion would exist, and these jets had been more fully explained to the operator than almost any other part of the producer, because through them the fire could be most easily regulated, and while they were automatic in regulation within certain limits of the engine load, it was necessary to watch them in case of extreme conditions. While the erecting man was in charge and teaching the producer man, the plant had been in operation daily from 7 a.m. to 5:30 p.m. without shutdowns or serious troubles of any kind, and the plant was turned over and left in his charge in excellent condition and with confidence that it would continue satisfactory. About 30 days later the builder received a letter saying that the producer plant was giving lots of trouble, that they were not able to get enough gas to run the engine for more than two or three hours at a time, and then they had to shut down, poke the fire and blow it up for some time before they could get gas good enough to run the engine. A number of letters were exchanged with the desire to ascertain the cause of the trouble and suggest a remedy until finally a telegram was received stating that the plant was shut down, that the producer was not what it had been represented, and unless immediately fixed it would be thrown out.

A "Rush to the Rescue"

The manufacturer and his erecting engineer, who had operated the plant successfully for 30 days, rushed to the rescue. When they arrived at the plant and examined the producer the interior of the generator was one immense solid clinker nearly 3 feet in diameter and almost the entire length. It was impossible to break it up for removal through the doors or the top, and crow-bars and long cold chisels with sledges would only chip off small pieces. The entire top had to be removed from the producer, and block and tackle rigged to lift out pieces as they were chiseled loose from the side walls and grate. Four days were required to get the producer back into commission again, Inquiry developed the fact that the steam jets had not been used after the erecting man had left because the operator had forgotten to turn them on one morning, and that forenoon they had made "better gas than ever before," so the operator had consulted with the superintendent of the works and together they had decided that the men who had built the plant and the man who had installed it did not know as much about running a gas-producer plant as they themselves did; that the use of steam in a producer was a mistake, that the engine ran much better without it, and that they would show the builders a new wrinkle in producer operation. They did. It was lifted out with a block and tackle and part of it is now on exhibition at the plant. The superintendent is man enough, however, to point to it and say: "See what a d——n fool can do." The present operator is handling the producer plant according to instructions, and they have had no further shutdowns.

Aside from not using steam in this plant, there was a slight tendency to clinker trouble due to the dimensions of the producer, with respect to the load it was liable to carry. It was only 48 inches inside diameter, and it was furnishing gas to a 150-horse-power gas-engine that often ran at full load for several hours. Had this producer been dimensioned on the basis of 1¼ pounds of coal per horse-power-hour and 10 pounds of coal per square foot of grate area, it would have been 59 inches inside diameter, and even without steam would never have clinkered as this one did in the same length of time.

Another Serious Case

Another case of serious trouble and shut-down was occasioned by an operator working too hard and trying to do too much. This man had assisted the erecting man in the installation and starting up of the plant. He had been picked up from the streets as a laborer, but had shown an unusual willingness to work, an aptness to do the right thing at the right time; he was always ready to pick up and hand the right tools as needed without being asked, and when the plant was ready to be put into operation watched carefully every move made by the erecting man asked pertinent questions as to the why and wherefore of action or change—in fact, he had shown such intelligent interest that he was recommended to the owner of the plant as a good man to put in charge as producer operator, and was selected. He followed the erecting man's every move, watched every action, tried to keep himself busy and seemed in actual fear every time the boss came around that unless he was working he would lose his job. The place was swept every few moments, the engine wiped off, bright spots polished, oil cups kept full, and everything in place. While the erecting man was there to direct him everything went well; finally the plant was turned over to him to operate alone, the erecting man went home with a certificate that the plant was satisfactory and accepted.

A month went by, the plant had been in operation every working day, was ready every morning, and carried its load without stops or shut-downs. The superintendent had reported to the proprietor that the engineer was "an awful hard worker," and that it was surprising how much work was necessary to operate and care for a gas-producer and engine, and it was also surprising how much fuel they were using. The very night this conversation had occurred the watchman called up the proprietor on the 'phone and told him he had just found the engineer outside the engine room, unconscious. An ambulance was called and the engineer taken to the hospital, where he died a few days after. Cause, overwork and insufficient nourishment and rest. The coal bill came in about this time and the new producer man reported that there was no grate in the producer, and the entire bottom around the place where the grate had been was burned out. The coal bill showed they had consumed about 5 pounds of coal per horse-power-hour, while the hustling engineer had had charge, and examination of the ash pile showed how hard he had worked in poking out good, live coals from the grate. He had barred his fire every few moments and kept the hottest fire immediately on the grate. As the fire worked up into the producer away from the grate he raked out everything and barred it down again until he had melted not only the grate, but the lining around it and wheeled it out with the unconsumed coals as ashes, while he added fresh fuel to the top of the producer to take its place. The oil bill also showed that he had used in the month a can of cylinder-oil sufficient to last the plant six months, and other oils enough to cover the engine foundation and floor. The poor fellow who had never done any-

thing but common labor, and had always been directed by someone else, when promoted to a position of responsibility supposed that the only way to keep the place was by keeping himself constantly busy. The actual duties necessary did not consume all of his time, so he had done them over and over again, worked himself to death, burned up the producer and used about five times as much fuel as necessary. This plant is now handled with discretion and is entirely satisfactory.

Induced-draft Producer Plant

An induced-draft producer plant was installed and operated for some time by the manufacturers, and every feature of its operation was said to have been fully explained to the new operator, who had formerly been the engineer of the steam plant which the producer and engine had superseded. The exhauster of this plant was said to have been arranged to maintain a vacuum of 4 to 8 inches of water. The erecting engineer says that during the 60 days he was in charge of the plant there was only one occasion when the vacuum was over 8 inches.

This plant was run for five and a half days every week without removing ashes, and then entirely cleaned out and a fresh fire started. The cleaning out was done every Saturday afternoon, and a new fire was built and left on natural draft until Monday morning, when it usually was ready for the week's run. After each clean-out it was the custom to put back about 10 or 12 inches of ashes on the grate to protect it from burning out. These weekly clean-outs were an unpleasant task, hurried through as quickly as possible. It seemed a foolish operation to rake out all these ashes from the grate and then have to shovel them back again, so the operator concluded to leave as many ashes on the grate as possible and save the labor of handling. These weekly leavings soon packed so firmly on the grate that the average vacuum after a cleaning was 12 to 14 inches. The wet scrubber discharges its waste water through a drop U-pipe 20 inches below the bottom of the gas-inlet pipe. As long as the vacuum on the exhaust line does not exceed the drop of this waste pipe there is no trouble, but when the vacuum gets higher, the overflow ceases, water backs up in the wet scrubber, overflows back through the inlet pipe and finally entirely stops the passage of gas from the producer causing a shut-down. After a few of these shut-downs an examination of the producer showed that the grate was almost entirely closed with clinker; removing this and working the producer rationally brought the vacuum down again to its normal value.

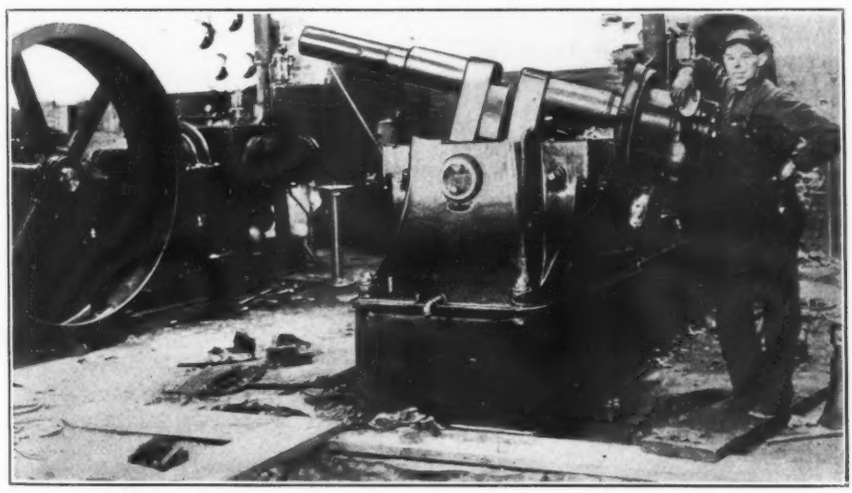
Fly Wheel Explosions

Explosion at Hearn's Stables, New York

The nine-foot fly-wheel of one of the engines located in the basement of the Hearn's department-store stables at 20 and 22 West Thirtieth street, New York City, burst about midnight July 7, and the fragments ruptured two 7-inch steam pipes. The engine and engine room were considerably damaged. The engine drove a dynamo which furnished light and power to the Hearn store and stables. Engineer Thomas Hughes was slightly scalded, and somewhat bruised in his effort to escape from the engine room.

The complete facts regarding the accident cannot be learned. When a representative of Power and The Engineer attempted to inspect the wrecked plant he met the chief engineer, who was afraid to say anything under penalty of losing his position, and therefore referred the representative to the "powers that be," higher up. The "powers" stated in positive terms that nothing would be given out for publication and declared that every employee connected with the plant had received orders to say absolutely nothing pertaining to the accident under penalty of instant discharge. This, of course, accounts for the reticence of the chief engineer.

Obviously, there was a cause for the wreck; quite as obviously, there was a determination on the part of those concerned to prevent anyone else from ascertaining that cause. This rigid secrecy, concerning which no explanation whatever was vouchsafed, has not a pretty aspect.



FLY-WHEEL WRECK AT THE LACOMBE PLANT OF THE DENVER COMPANY

A Bad Wreck at Denver

On June 24 a fly-wheel in the La Combe plant of the Denver Gas and Electric Company exploded, badly damaged the engine, wrecked a couple of dynamos and tore several holes in the building. One large piece of the rim was thrown through the boiler room, but did not strike the boilers. While the exact cause of the accident is unknown, it is the opinion of the employees that the governor became deranged, allowing the engine to run away.

The wheel was only 7 feet in diameter, but the property loss, said to be $5000, will fall on the Denver company, as it had no insurance on this wheel.

Accident at Riverpoint, R. I.

The fly-wheel of the Corliss engine at the Royal mills, Riverpoint, R. I., burst as the engine was being started on the afternoon of June 19. Part of the wheel crashed through three floors. The engine room, part of the cloth room immediately over the engine room, part of the carding room, and part of the ring-spinning room were damaged.

The cause of the accident is unknown. When the steam was turned on after the noon-hour stop, the engine, so far as could be seen, was in its normal condition. A few moments later, however, it was noticed by the engineer that the engine seemed to be "racing."

The United States Civil Service Commission announces an examination on August 3 to secure eligibles to the position of chief engineer, class 3, in the Coast and Geodetic Survey, for service in the Philippines, at $115 per month. The department states that the appointee will, upon his arrival at Manila, be promoted to the position of chief engineer, first class, at $140 per month. Application form 304 and special forms will be required.

The addresses delivered at the installation of Prof. W. F. M. Goss as dean of the College of Engineering, University of Illinois, have been published in the university *Bulletin*, No. 21, for April 22, 1908, this bulletin being the first of the College of Engineering series. The bulletin contains 60 pages, 6x9 inches, has half-tone portraits of the present and former deans, program of the exercises, list of special guests and biographical data of Professor Goss.

Lubrication as a Factor of Engine Economy

By William E. Snow

Some two years ago four first-class armored cruisers of the United States Navy were put out of commission in a period of less than ten months by burnt-out boiler tubes. The presence of a certain amount of oil in the exhaust steam is one of the necessary evils of the reciprocating engine, and where this steam is condensed and the water returned to the boilers, as is the practice on shipboard, the tubes become more or less coated with the oil, rendering them susceptible to injury from the action of the hot gases. A certain amount of depreciation from this cause is always expected in boilers, but in the above-mentioned instance this had assumed such abnormal proportions that the Bureau of Equipment decided to investigate the matter.

On the four vessels the equipment in question was practically the same, and an examination of the main engines showed but a very ordinary amount of oil in the exhaust—nothing to cause marked trouble with the boilers. Examination of the auxiliaries, however, disclosed the trouble, which was located in the exhaust from the lighting sets. On each vessel there were six of these, of 100 kilowatts capacity, in constant operation day and night. As no lubrication was used in the cylinders of these engines, they had not previously been considered as a possible source of boiler troubles. A careful test, however, showed the presence of 2.2 ounces of oil per hour in the exhaust from each engine. With all six engines in constant operation, oil was being carried into the boilers at the rate of one gallon every four days—a quantity quite sufficient to cause serious trouble.

Piston-rods Pump Oil into the Cylinder

These engines were of the vertical compound inclosed type, and as no cylinder lubrication was used, this oil could have found its way into the cylinders in but one manner, and that by means of the piston-rods. Investigation proved this to be the case, and a study of the accompanying illustrations will explain the reason why. Fig. 1 shows a sectional elevation of one of the engines. Lubrication is supplied from an oil well in the base by means of a pump, all the working parts being practically bathed in oil. A watershed partition is provided at *A* to prevent any water leaking past the piston-rod stuffing-boxes *B* from mixing with the oil in the engine case. The partition is in turn provided with stuffing-boxes *C*, which serve the double purpose of keeping the water out and the oil in.

Fig. 2 is a cross-section of one of the cylinders, showing the piston *F* at the bottom of the stroke. The point *D* on the piston-rod has passed down through the packings *B* and *C* into the oil-tight case below the watershed partition *A*. While in this position this portion of the rod becomes covered with the oil that is thrown about inside the case by the working parts of the engine. Fig. 3 is a cross-section of the same cylinder showing the piston *F* at the top of the stroke. The point *D* on the piston-rod has now passed up through the stuffing-boxes *B* and *C* into the cylinder *E*, where many of the small particles of oil still adhering to the rod are deposited. In this manner, a little at each stroke, the piston-rods of these engines were pumping oil from the case up into the cylinders at the rate of seven or eight gallons per month, with most disastrous results to the boilers. If cylinder lubrication had been used in these engines, the amount of oil fed into the cylinders for this purpose would have been less than one-sixth the quantity pumped in by the piston-rods.

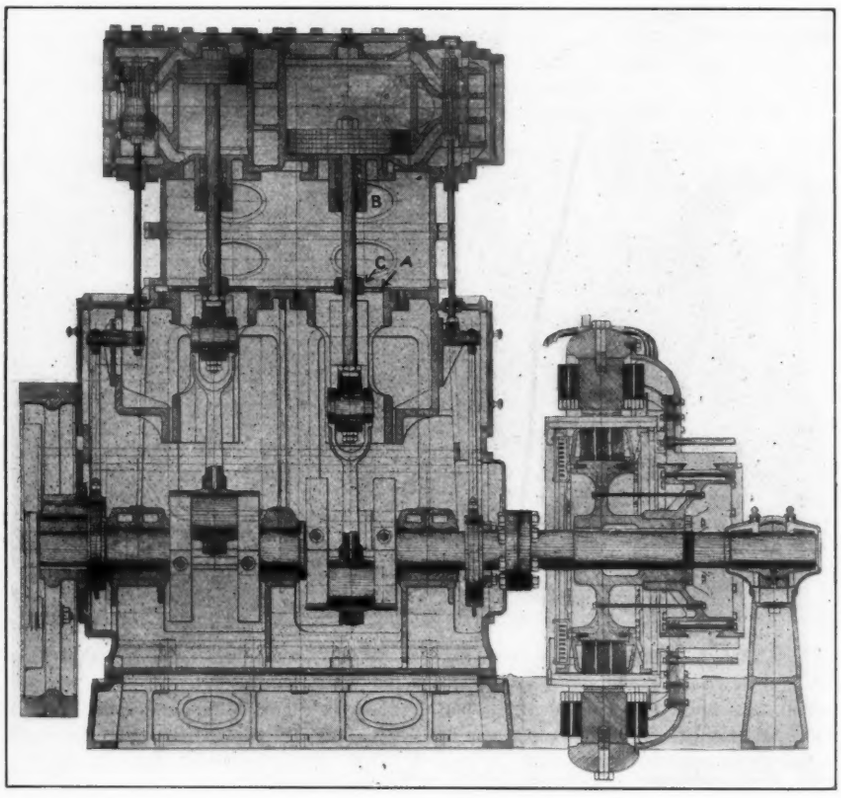


FIG. 1. VERTICAL COMPOUND INCLOSED TYPE OF ENGINE

Raise Cylinders to Stop Entrance of Oil

To remedy this trouble the Bureau of Equipment had the design of these engines changed by raising the cylinders some few inches, as in Fig. 4. The piston is here shown at the bottom of the stroke, as in Fig. 2, but the point *D* on the piston-rod does not pass through the stuffing-box *C* in the watershed partition into the engine case as it did before, and is therefore prevented from dipping into the oil. In this manner the portions of the piston-rod that enter the cylinder are kept free from oil, and the exhaust steam rendered comparatively harmless to the boilers.

New cylinders, made in accordance with this change of design, were fitted to the engines in the four cruisers and longer piston-rods put in. As an unforeseen but natural consequence of this change, the engines now failed to pass the necessary economy test. The specifications of the United States Navy require that the 100-kilowatt lighting set shall, operating under a steam pressure of 150 pounds gage with a vacuum of 20 inches, show a steam consumption of 31 pounds or better per kilowatt-hour, without lubrication of the cylinders. Previous to this change in design the engines furnished the Government had easily met this requirement, averaging under the specified conditions 30.2 pounds of steam per kilowatt-hour, but although supposed to be operating without cylinder lubrication, the engines of the old design had in reality been getting large amounts of oil from the piston-rods. With the change of design this oil supply was completely cut off and the engines were operated with the cylinders actually dry of oil. A great falling off in economy was at once apparent, the steam consumption increasing to 36.3 pounds per kilowatt-hour, and showing conclusively that the economy of a reciprocating engine is to a large extent dependent upon the proper lubrication of the cylinders.

Cylinder Lubrication Essential to Economy

A series of tests were taken on one of these re-designed engines to determine the effect of varying quantities of cylinder oil upon the economy. Starting with 2.2 ounces of oil per hour, which was the amount found originally in the exhaust from each engine, the quantity was gradually reduced until in the last test no oil at all was used. The results of these tests will be seen in the accompanying table, the pressure being 150 pounds and the vacuum 20 inches in each case.

Kind of Lubricant.	Ounces of Lubricant Used per Hour.	Pounds Steam per Kw.-hour.
Oil.....	2.2	29.7
Oil.....	1.0	30.9
Oil.....	0.5	33.1
None.....	....	36.1
Kerosene...	3.0	34.2
Gasolene...	3.0	34.7
Soda Solution....	10.0	37 2

It being desired to take a similar test with the cylinders absolutely dry, kero-

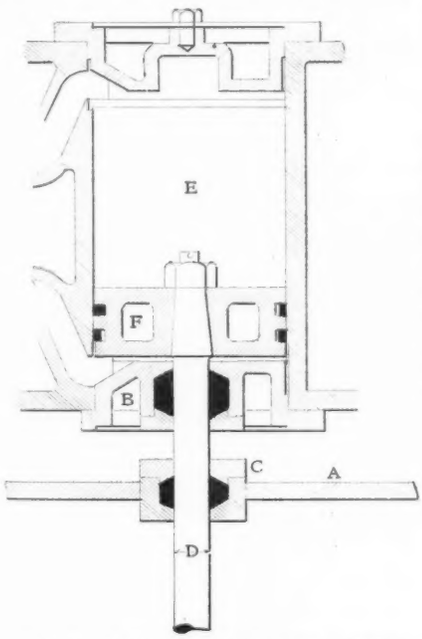


FIG. 2. PISTON AT BOTTOM OF STROKE

sene and then gasolene were injected into the cylinders to clean them from any oil that might have been left over from the previous tests. As is evident from the table, these acted as lubricants, decreasing the steam consumption considerably, so a strong solution of soda was finally resorted to, with the result indicated in the table. While running this last test it was noticed that the cylinders heated quite badly, making any continued operation under the conditions impossible. When fed with kerosene and gasolene, however, the engine showed no signs of distress.

From the figures in the table it will be seen that an engine loses 20 per cent. in efficiency when the lubrication of the cylinders is cut off. There are two reasons for this: the increased leakage of the steam past the piston and rings due to the absence of the oil film on the cylinder walls, and the increase of heat radiation from the same cause. This is more readily apparent in the case of the internal-combustion engine. If a gasolene engine with a good strong compression, indicating a tight fitting piston and rings, is taken

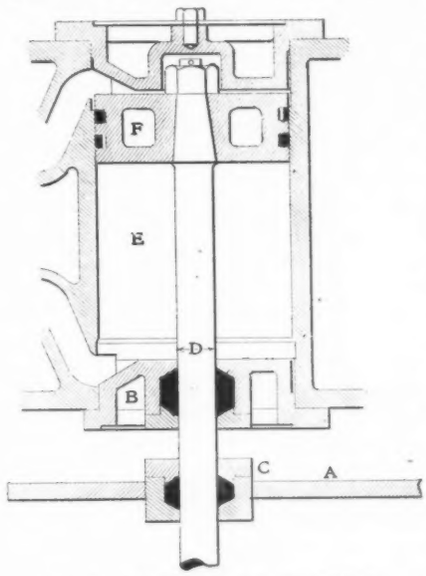


FIG. 3. PISTON AT TOP OF STROKE

apart and the cylinder, piston and rings thoroughly cleaned of oil, it will be found upon putting it together again that practically all the compression is lost. In fact, it will be found impossible to even produce combustion. If an ounce or so of oil is injected into the cylinder and the piston worked back and forth a few times to distribute the oil over the cylinder walls the compression will return. In a steam-

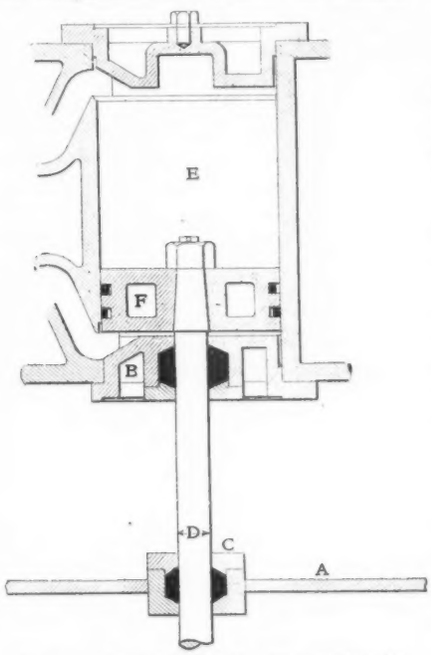


FIG. 4. CYLINDER RAISED OVER ORIGINAL DESIGN

engine cylinder the leakage from this cause cannot, of course, be as great because the water of the condensed steam to some extent takes the place of the oil in keeping the piston tight.

Regarding the radiation losses, it is known that the efficiency of radiators on water-cooled gasolene engines is seriously impaired by the presence of oil in the water, due to a leaky cylinder-head gasket or pump packing. This oil coats the cooling tubes and, being a non-conductor of heat, prevents proper cooling of the water. The presence of a film of oil upon the cylinder walls of a steam engine forms a protection against heat radiation, and when this is removed the effect upon the economy of the engine is by no means small. As already stated, the loss in efficiency of these engines from these two causes alone was 20 per cent., which shows that proper lubrication of the cylinders is as essential to the economy of an engine as the setting of the valves themselves.

The results of these tests were submitted to the Bureau of Equipment of the Navy, which, after due consideration of the matter, changed the original specifications to permit the use of a moderate quantity of lubricating oil in the cylinders of these redesigned engines. Under this condition the engines readily passed the economy test and were accepted by the Government.

International Congress of Inventors

A discussion having arisen in various parts of the country regarding the status of the inventor with relation to the United States Patent Office, and expressive of the opinion that the inventors of the country should form a national organization for the protection and advancement of their interests, we are requested to state that just such an organization exists in the International Congress of Inventors, established in 1906, incorporated in 1907, and having members in several States of the Union, with branches formed or forming in Texas, Missouri, Illinois and California. This organization was established to benefit inventors as a class by seeking to secure legislation which shall insure to the inventor the services at the Patent Office which his application fees should provide, and the protection for his invention which a government guaranty should give.

Largely through the efforts of the International Congress of Inventors the Federal Congress has this year provided for an increased force of examiners in the Patent Office and for an advance in the salaries of Patent Office employees, which will tend to retain in Government employ those who have become expert in the treatment of applications.

An important matter under consideration by the organization is the establishment of a standard for a United States patent. Suggestions in the interest of inventors and all who hold patents are solicited by this organization. Ralph T. Olcott, Rochester, N. Y., is the secretary.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1907 *we printed and circulated* 291,500 *copies of* POWER.

Our circulation for June, 1908, *was (weekly and monthly)* 195,000.

July 7	36,000
July 14	40,000
July 21	40,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Preventing Fly Wheel Explosions

The frequency with which fly-wheel explosions occur reveals that the dangers of the steam plant are not confined to the boiler room alone. The increasing number of these accidents suggests lack of proper vigilance on the part of the engineer in detecting faulty conditions. We have yet to learn of a fly-wheel failing from weakness or faults of construction while operating under normal conditions.

Usually the blame is placed on the governor, as failing to govern properly. This makes an excellent excuse; it is to the point, and no one can contradict the assertion. It lets the engineer "down easy," and usually satisfies the owner. What seems farthest from the minds of all concerned is, why did the governor fail to govern? The owner does not know, and if the engineer knows he does not tell.

There have been many fly-wheel explosions where the circumstances were such that the utmost vigilance on the part of the engineer could not in any way have prevented them; but, on the other hand, scores of fly-wheel accidents have been caused by neglect, carelessness and lack of common sense.

No good engineer would think of washing out a boiler without examining the braces, rivets, etc., yet there is no more reason to expect that these particular features have become defective than that the bolts in the rim and hubs of a fly-wheel have loosened up, or that the safety devices on the engine have become deranged. Probably one reason for strict attention being paid to the vital parts in boiler inspection is due to the constant pointing out of the necessity of so doing, while the vital points regarding the safety of the engine are more often passed over. When an engineer omits to examine frequently his fly-wheel, safety devices and apparatus which can in any way contribute to an accident, he is guilty of gross neglect of duty. If he thinks of doing these things, but puts it off from day to day, he is guilty of carelessness of the worst kind. If he does not remove the safety pin (if the engine is so equipped), if he removes the safety knock-off block for various reasons, or if he permits an old oil-soaked belt to drive the governor, he is lacking in ordinary common sense.

You, Mr. Engineer, are operating an engine. You would be offended should one venture to call you neglectful, careless or lacking in common sense; but what precautions are you taking to prevent your engine from running away? We will venture to say that not more than one in one hundred engineers who are operating high-speed engines has ever taken the time and trouble to disassemble the fly-wheel governors to clean them and examine them for defects. The policy seems to be that just so long as the governor operates "after a fashion" there is little use of inspecting it.

Not infrequently we hear of a governor failing to govern properly because it had become gummed up. This is no excuse for such trouble, as we all know; it is nothing but the result of neglect. The breaking of belts, shafts and pulleys and neglected safety pins and cams are responsible for most fly-wheel explosions, other than those due to faults in the governor. In nine cases out of ten a careful examination of the parts enumerated would have disclosed flaws which later proved disastrous.

That an engine is equipped with automatic safety stops and the like is no reason why the engineer should lie back and assume that the safety devices will always operate properly and never get out of order. They do get out of order, as so many fly-wheel explosions testify. As a means of reducing the number of fly-wheel explosions we would suggest greater care and more frequent attention to such points as can in any way retard the functions of the governor.

The Setting of Commutator Brushes

Recently we printed communications from several readers who advanced varying opinions as to the best way in which the carbon brushes of direct-current dynamos and motors should be set with reference to the rotation of the commutator. It is undeniably true that with certain types of brush-rigging, carbon brushes work better trailing than they do when pointed against the direction of commutator motion; it is equally true, however, that with other types of brush-holder the brushes work much better "toed" against the direction of rotation. We have in mind the case of a 500-kilowatt generator equipped with box-type brush-holders through which simple carbon blocks were pressed toward the commutator by flat springs. This machine could not be made to run sparklessly with the brushes set any other way than slightly slanted so that the thrust due to the motion of the commutator tended to back the brushes away from the commutator surface. This and similar experiences have demonstrated very clearly that no general law can be laid down for this feature of brush-setting which takes into account merely the resultant of the forces exerted by the moving commutator surface and the brush springs; in other words, it cannot be stated, with accuracy, that all carbon brushes should or should not be set in any one fashion. It will be found in every case that there is a certain angle at which the brushes work best, and this angle not only varies in extent and direction in different machines, but may easily be varied considerably in a given machine by

changes in the condition of the commutator, brush springs, and brush-holders.

The discussion of this simple but really important subject brings to mind the ancient truth that it is not safe to generalize too widely. Nowhere does this maxim apply more forcibly than in electrical engineering.

A Plea for a Standard Catalog Size

Not the least valuable nor the least used portion of an engineer's library consists of the trade catalogs which come to him from time to time; nor is the problem of a satisfactory method of filing these catalogs the one which gives him less concern than any other. The catalogs of some manufacturers contain a great deal of technical information in concise form, prepared for use by engineers employed by the manufacturers. But it is to be regretted that most, if not all, efforts on the part of those who have tried to secure uniformity in the size of catalog pages have failed, and the engineer who attempts to systematize the filing of mechanical and engineering literature is met by almost insuperable difficulties caused by wide differences in page sizes. In one collection of approximately 3000 catalogs there were found to be nearly 600 different page sizes, varying from 2¼x4 inches to 12x16 inches, and one 6x24 inches.

Convenience in filing for purposes of future reference is often the deciding factor whether a catalog goes to a book shelf or to the waste basket, and the loss when the waste-basket route is selected falls on the manufacturer who unthinkingly selects a mongrel-sized page for a publication which if uniform with others relating to the same line of work would find a welcome and would be placed where it could be used when needed. In times past several committees have performed the thankless task of calling the attention of manufacturers to the advantages of standards in the matter of trade catalogs, and some of these committees have suggested the sizes 3½x5, 6x9 and 9x12 as being most likely to be acceptable, although why 3½x5 inches should be preferred to 4½x6 inches is not apparent any more than is the need for the 9x12-inch size.

Numberless pleas, editorial and otherwise, have been made in the effort to secure uniformity and to convince the manufacturers that a catalog which could be easily filed could contain as much and as useful matter as one which on account of its ungainly proportions would at once start on its journey to the fire-room or to the junk man. Engineers are very much like other men; they prefer order and neatness on their book shelves as well as in the engine room, and the book which will not fit in the row where from the nature of its contents it belongs is an eyesore and annoyance.

"Do It Now"

Had the pilot changed the course of the ship when common sense dictated, the ship would not have been lost; had not the locomotive engineer tried to make a distant siding contrary to orders, to save a little time, the wreck would not have occurred; had the fireman watched the water-glass more carefully the boiler would not have been burned; had the engineer made the necessary repairs when the defects were first discovered the explosion would have been prevented. It *pays* to "do it now."

In a mill two lines of five-inch shafting were connected by means of flanged gears, one placed above the other. As the teeth wore, the gears developed a tendency to jump out of mesh, and, being midway between the walls of the building, the spring of the flooring assisted this tendency. When the teeth did finally mount each other a crash was inevitable, as the teeth were stripped and that portion of the mill driven by the line of shafting in question was out of operation until new gears could be put in place. As there were several days' warning of what might be expected, there was no excuse for allowing the gears to remain in operation until they were stripped. The work of renewing the gears could have been carried on at night, to avoid shutting down several departments.

A boiler plate begins to bag, but the engineer looks it over and decides that as the weather is hot (or it may be cold), it can go as it is without endangering the plant. Anyhow, there is always something to prevent taking the bag out of the plate, until it becomes so large as to be unsafe and the plant has to be shut down while a patch is put on. Had the engineer belonged to the "Do It Now" club, it would have been dollars saved for the firm.

Many an engineer knows that the safety stop on his engine will not operate, but he does not take the time to make the few necessary changes to correct it. It has been in that condition for months and nothing has happened, and so he concludes that it is "a small matter." There is an "if" to be reckoned with, however, and when a thing is really wanted, in most cases it is desperately wanted. When something ought to be done, what is to be gained by putting it off? It is far better to take up the most disagreeably difficult work first; with that out of the way, ordinary repair work seems comparatively simple and the engineer wonders that he ever considered his work "drudgery."

All men require one day in seven to rest; but many an engineer does not come into his own in this respect. This is usually nobody's fault but his own. The practice of letting things go until Sunday, before repairing them, is poor policy. Maybe the pump requires packing; it will only take a few minutes on Sunday morning. By the end of the week enough work has accumulated to keep the put-it-off engineer busy the greater part of Sunday. There is no need of such mismanagement. Carrying out the "do it now" policy would give to the engineer many a leisure hour, the lack of which he now deplores.

Foresight is another desirable attribute. The engineer who produces results is the one who always keeps his apparatus ready for operation. Summer and winter there are certain apparatus which are idle, each being used in its season. The wise engineer, besides keeping up with his everyday duties, will put such apparatus in first-class condition ready for service when required. By following this plan nothing will be done in a hurry, and there will be no awkward delay when a machine is wanted; the engineer will have confidence in his plant, as well as in himself; there will be smoothness in the entire plant's operation, and the engineer will have an "easy snap," just because he is a believer in the policy of "Do It Now!"

Fire Brick

There is a crying demand all over the country for fire-brick, better fire-brick, fire-brick that won't spawl or melt and which will "stay put" long enough to let the furnace do its quota of the work. One large electric company has an expert scouring the country for brick which will stand up to its work. The manager of a boiler company says that they will get one consignment of brick which behaves beautifully and perhaps the next consignment from the same yards will go all to pieces. The brick manufacturer who could satisfy the demands of these people and of others similarly circumstanced would find a large and profitable business awaiting him. The service which is demanded of fire-brick is becoming more exacting. Rates of combustion are higher, furnaces are roofed over, excess air is kept down and everything tends to higher furnace temperatures. Furthermore in many services, especially in electrical work, the demand for steam is very irregular, and the frequent change of temperature of the furnace from the white heat of the peak load to the banked fire of the lay-off period is not conducive to integrity and long life in the linings.

Surprising results are being got out of boilers. A few years ago fifteen square feet of surface was thought necessary per horse-power. Today boilers rated upon ten square feet are run 100 per cent. above their rated capacity with no falling off in efficiency. This makes such a difference in the standing charges composed of interest, depreciation, etc., upon the building and apparatus that it is very desirable to keep to it as regular practice if furnaces can be built which will not be so much out of service and cost so much for repairs as to nullify these advantages.

Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

New Model Roney Mechanical Stoker

The Westinghouse Machine Company, East Pittsburg, Penn., has designed a new model of the Roney mechanical stoker. Some of the most important features in connection with its design is that the number of complete grate bars has been reduced one-half over that used with the old type of stoker. The tops, webs, guards and dumping grates are interchangeable. The grate bars automatically center themselves in the side bearings by their own weight; they may also be re-distributed so as to equalize wear over all parts of the furnace. The guard and dumping grates are interchangeable without disturbing the side or center bearings. Fig. 1 shows the stoker as it appears in a furnace setting.

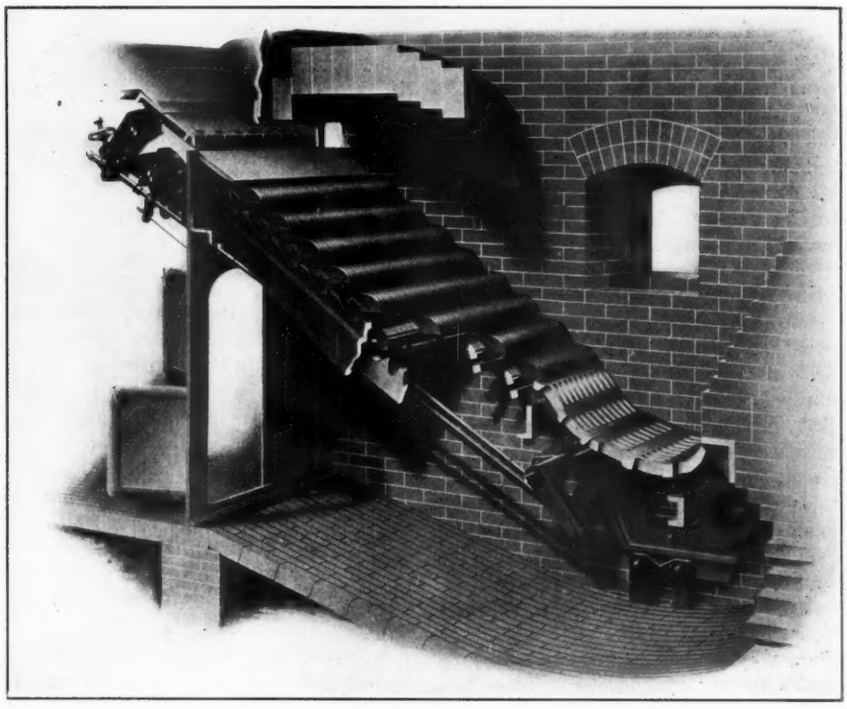


FIG. 1. NEW RONEY STOKER AS IT APPEARS IN FURNACE

For the upper four grates a non-sifting type of top is used, provided with abutting horizontal ledges to prevent the fine fuel from sifting through the bars, and at the same time permit a free entrance of the air. For each square foot of grate exposed to the fire, 7.4 square feet of surface is cooled by the air, giving 7.4 times the cooling effect of the flat-top grate bar.

As will be seen from Fig. 2, the grate proper consists of a number of thin plates set on edge in V-grooves. These hook over a trussed web, and are held in place by a key-rod slipped in from the end. They are, therefore, easily removed. One of the principal advantages of the sectional grate-bar tops is that it reduces the amount of scrap when they have been sufficiently worn to be discarded. In this stoker no bolts are used, and any part can be removed without disturbing the other.

The new type of guard prevents the fire from sliding into the ash-pit when the dumping grate is operated. As the lower end of the guard is now raised, instead of cutting through the fire, as formerly, it not only makes it possible to dislodge from the fire all clinker formed at the bottom, but also provides an unobstructed descent for the ash and clinker separately. When dropped to its normal position, it permits the lower edge of the fire to settle quietly without a tendency to slide.

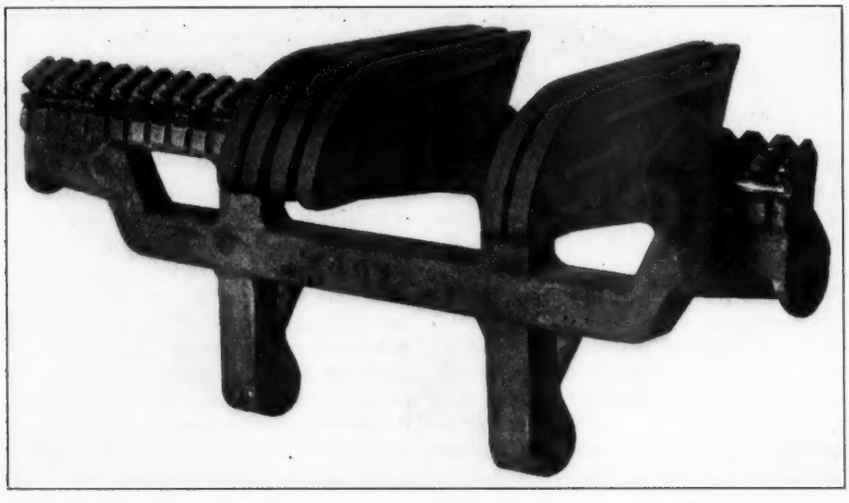


FIG. 2. SHOWING CONSTRUCTION OF GRATE

The new dumping grate is hinged about one-third forward, dumping both front and rear. Being nearly balanced, it is very easily operated. The upward motion of the dumping grate breaks up any clinker bridge tending to form between the grates and bridge-wall. Both the dumping guard and grates rest in U-shaped trunnions in the side bearers, the guard being simply hooked over the bearing rods as shown in Fig. 3. The latter can, therefore, be easily removed without dismantling any portion of the stoker.

The rocking motion is transmitted to the grate bars by means of a connecting-rod from the eccentric "agitator." As the grate-bar tops are unbalanced, they return to the inclined position by their own weight, and, therefore, only one feed adjustment is necessary, made by the sheath nut on the end of the connecting rod, as

motion is transmitted to the connecting rod in one direction only, by the agitator. A simple locking device, or dog, is used for holding the grates open to permit rapid trimming of the fires, as shown in Fig. 3.

The air supply to effect the combustion of volatile hydrocarbons is admitted through two wind-gates located on either side of the stoker. It first passes to the rear of the fire-brick arch, extending across the front of the furnace, and is then directed by baffles to the crown of the arch, at which point it enters the front air spaces. From the latter, it enters the furnace through the spaces between the stoker front and the first ring of arch brick. Passing the air over the furnace in this manner not only pre-heats the air, but assists materially in cooling the arch.

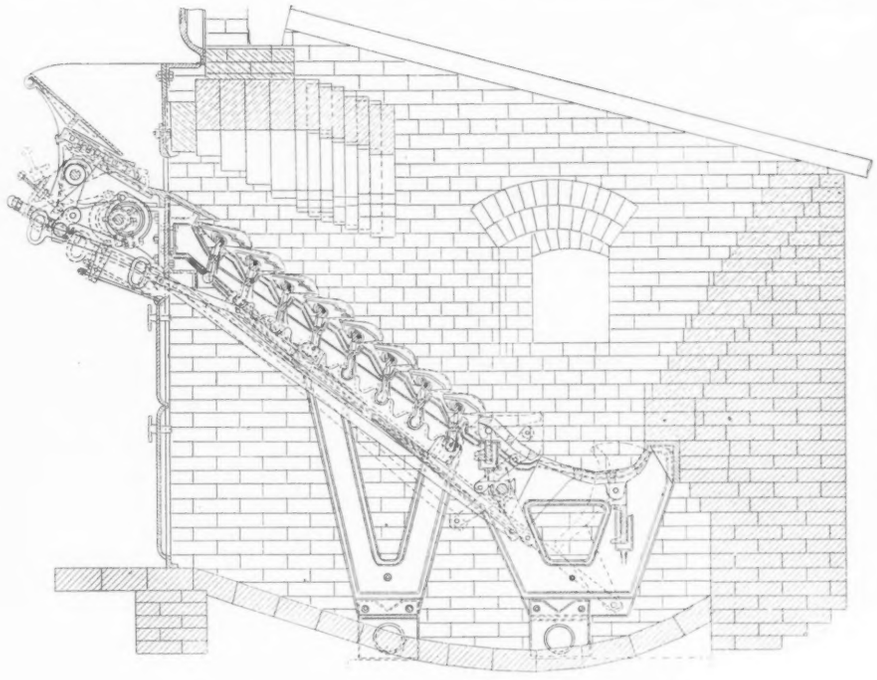


FIG. 3. SECTIONAL SIDE ELEVATION OF RONEY STOKER

Coal is fed into a hopper extending across the boiler front, usually by gravity from an overhead bin. From this hopper the fuel is automatically supplied to the furnace by a reciprocating pusher operated from the rock shaft by an eccentric. The fuel descends through the throat of the arch onto the upper grate bars, where it is subjected to an intense heat radiated from the incandescent fire-brick arch spanning the upper portion of the furnace. This entirely cokes the fuel and drives off all the volatile gases, leaving the coke, or fixed carbon, which is then gradually worked down the inclined surface by the rocking motion of the grate bars, imparted to them from the eccentric on the rock shaft.

The oscillation of the grate bars not only works the fuel slowly down the furnace, but also keeps it constantly agitated, thus preventing to a large extent the formation of clinker, and bringing the fuel into intimate contact with the incoming air. After the solid combustibles have been totally consumed, the remaining ash is discharged onto the dumping grate at the bottom of the furnace. The operations necessary to clean the fire will be readily understood by reference to Figs. 1 and 3. First, the guard is raised to the position shown by the dotted lines, Fig. 3, thus preventing the fuel bed from sliding. Next, the dumping grate is dropped into the position shown by the dotted line, permitting the clinker and ash to pass to the ash pit, when the grate is brought back to its normal position.

Following is a record of seven months' wear of the type D sectional grate-bar top:

Sample No.	Weight, Pounds.	*Reduction, Per Cent. In Weight.	In Burning Surface.	Annual Depreciation,*Per Cent.	Approximate Life, Years.
1	2.375	17.4	38.7	66.3	1.51
2	2.625	8.7	23.7	40.6	2.46
3	2.625	8.7	16.7	28.6	3.49
4	2.75	4.3	11.3	19.4	5.16
5	2.562	10.9	10.0	17.1	5.83
6	2.69	6.4	7.4	12.7	7.88
7	2.562	10.9	4.8	8.2	12.1
8	2.812	2.1	3.2	5.5	18.2

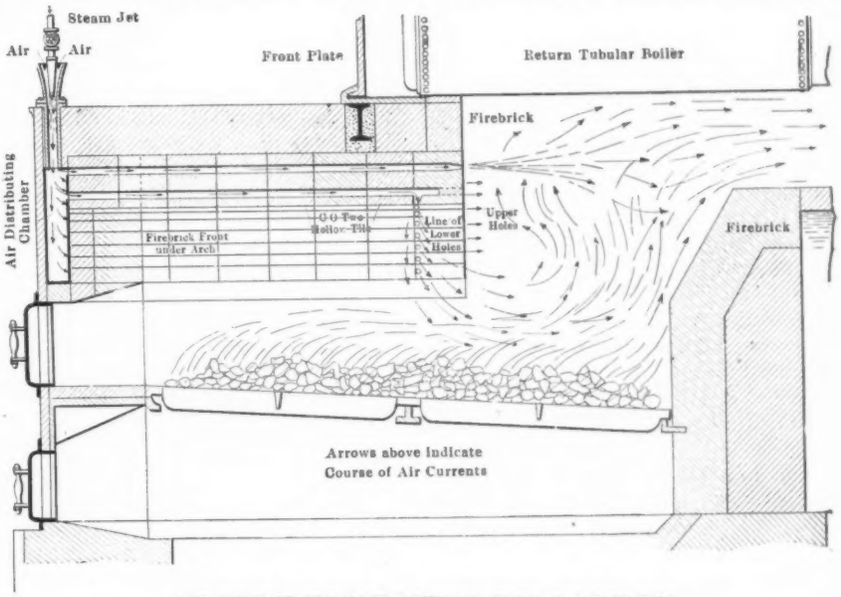
*Weight of original top, 2.875 pounds.

An average annual depreciation of about 17 per cent. is shown by these eight samples, indicating a probable life of about six years, if the bars are re-distributed from time to time. In the upper part of the furnace, however, the wear was practically *nil*. With the grates open a maximum width, the effective admission area of the entire gate is 36.8 per cent. of the project area of the furnace. At maximum opening, i.e., in their lower position, the effective opening is 24.2. Taking the actual time of opening and closing, the average effective draft area of this type of stoker is 27.4 per cent. of the total projected area, as compared with an average of 17.9 per cent. with flat, horizontal fire tops. This increased admission area makes it possible to maintain a higher rate of combustion.

C-O-Two Furnace Tile

A new form of refractory tile suitable for fire-arch or dutch-oven construction is manufactured by the C-O-Two Furnace Company, Syracuse, N. Y.

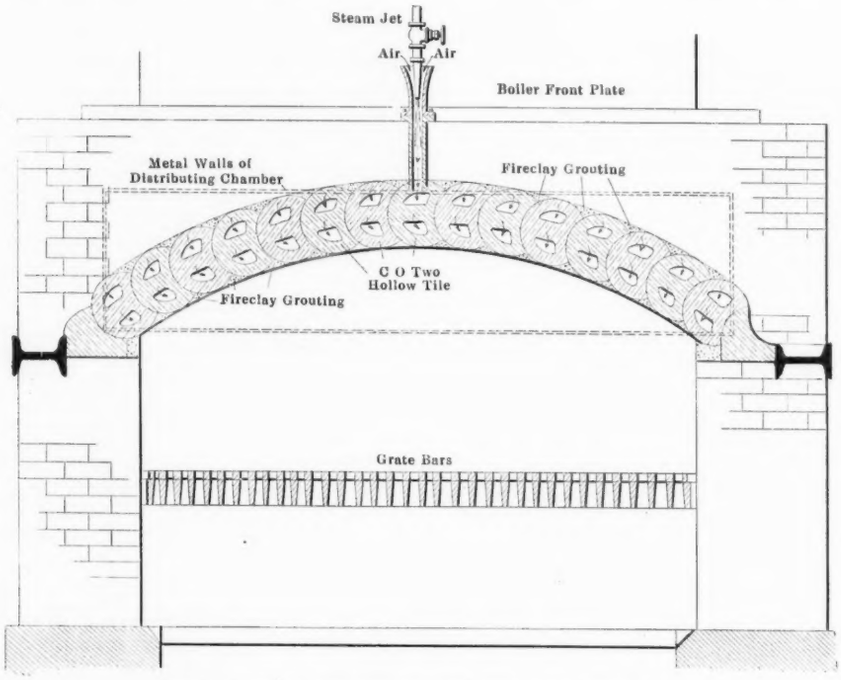
The tile sections are pierced by two holes, through which air is introduced to the furnace in nominal quantities, and, after being heated, is delivered at points most suitable for the mingling of oxygen with volatile matter. Air is admitted into the channels formed by the consecutive



SIDE VIEW OF FURNACE EQUIPPED WITH C-O-TWO TILE

tile members through a suitable distributing chamber located within the front wall, into which it is led by siphon action produced by a small steam jet or by blower. The air may also be taken in by natural draft or vacuum, in which case individual openings should be provided at the front.

The exit ports are produced by suitable cutting of the tile, shaped and located at



FRONT VIEW OF C-O-TWO HOLLOW-TILE FIRE ARCH

convenient points of the arch, depending upon furnace and boiler designs, so that the air can escape at any desired angle of deflection. This will depend somewhat upon the relation between the furnace vacuum and the initial pressure of the air, plus its increase in volume gained by the absorption of heat during transmission.

The air may also be guided so as to form a return flow, entering first the upper channel, after flowing through which it enters and passes through the lower channel, finding its exit through the ports near the inner face of the front wall. The illustrations show the method of using these tiles in connection with a horizontal return-tubular boiler, although the system is perfectly applicable to any type of boiler where a low-grade fuel is to be used.

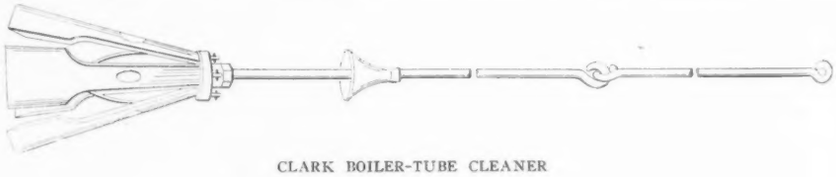
But a short time is required for erecting these arches, owing to the ready alinement of the tile members, which, because of their universal joints, will readily lend themselves to expansion and contraction.

To keep the oil of hanger-boxes from crawling a shaft, clamp a bit of wire between the ends of the hanger-boxes and caps, with the wire bearing on the shaft bent so as to steer the oil back into the box.

The Clark Boiler Tube Cleaner

The head of the Clark boiler-tube cleaner consists of four blades of tool steel formed as shown in the illustration. These blades are attached to the holder by sockets and pins, thus making it an easy matter to remove for re-grinding or renewal. The blades are held in an open position by means of four springs, two of which are shown, which force the blades out and the soot or scale is thus cleaned from the tube.

The rider acts as a rocker for the head and at the same time pushes out the loose soot and scale which may have fallen between the openings of the four blades. When being used, the blades are squeezed together by the hand, inserted in the tube and pushed through until the rider is felt to have passed out of the rear end of the tube. The head is then withdrawn to the front of the tube, turned slightly and pushed through again, thus thoroughly cleaning the tube. A type of this cleaner is made for vertical boilers, also. It is manufactured by the Fred Clark Boiler Cleaning Company, 93-99 Nassau street, New York City.



CLARK BOILER-TUBE CLEANER

In babbitting a box, everything should be heated very hot before pouring, so that the babbitt will be tight when it is cold.

Personal

Theodore T. Mersereau, formerly United States inspector of boilers of steam vessels at New York, has been appointed sales agent for the Casey-Hedges Company, boiler manufacturer, with headquarters at 100 William street, New York City.

Obituary

Nicholas J. Kelly, or "Nick" Kelly, as he was more familiarly known, died at his home in Buffalo, N. Y., Wednesday evening, July 8, after an illness of six weeks. He was born in Ireland 47 years ago and settled in Buffalo when 22 years old. He was well known as an engineer, being for several years chief engineer of the General Electric Company. Later he became interested in the Lake Erie & Depew Water Company, of which he was superintendent for some time and up to the time of his death. Mr. Kelly was a famous horseman and to this fact his death is indirectly due. About two months ago, while driving in a buggy, a wheel broke and he was thrown out. Being of powerful build, the shock was severe, and he was forced to give up his duties. Socially, politically and in athletics, Mr. Kelly was a prominent figure. At one time he was a Civil Service Commissioner at Buffalo. His friends were legion and he will be sorely missed.

The United States Civil Service Commission announces an examination on September 2 next to secure eligibles for the position of engineer in wood preservation at a salary of $1000 per annum. Application form 1312 will be required. The applicant must know something about preserving wood, chemistry and mechanical and civil engineering.

"Some Things a Manufacturer Should Know About Coal" is the title of a paper presented by E. G. Bailey, of the staff of the Arthur D. Little Laboratory, at the spring meeting of the National Cotton Manufacturers' Association. It has been reprinted as No. 3 of a series of reprints of professional papers presented by the staff of that laboratory for gratuitous distribution.

A small leak around a valve-stem on the pipe of the steam gage will cause the gage pointer to vibrate.

Inquiries

Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

What Is Meant by Tensile Strength

What is meant by tensile strength when applied to boilers?

A. G.

A tensile strain is a strain tending to stretch a thing, or to pull it apart, or just the opposite of a compressive strain. A weight hanging on a rope puts a tensile strain upon it. The pressure in a boiler tends to stretch the sheets.

Heat Units in Dry-saturated Steam

If the temperature of the steam in a boiler is 270 degrees and the feed water 100 degrees, how many units of heat will it take to turn a pound of it into steam?

A. M.

To make a pound of dry-saturated steam of 270 degrees from water at 32 degrees would require 1164.3 B.t.u. The water at 100 degrees would already have 68.08 more heat units per pound than at 32. To make a pound of the 100 degree water into a pound of steam at 270 degrees would, therefore, take 1164.3 — 68.08 = 1096.22 B.t.u.

Heat Units in Steam at 212 degrees

How many heat units are there in steam at 212 degrees?

I. N. C.

To make a pound of steam at 212 degrees and atmospheric pressure, 14.7 pounds absolute, from water at 32 degrees, would require 1146.6 B.t.u.

Total Heat in Steam of 110 Pounds Gage Pressure

What is the total heat in 100-pound gage steam?

G. E.

The temperature of steam of 115 pounds absolute pressure, which would be about 100 gage pressure, at sea level is 337.8 degrees Fahrenheit. To raise a pound of water from 32 degrees to this temperature would require 309.5 B.t.u.; to evaporate it into steam at that pressure and temperature, 875.5. The total heat in a pound of such steam above 32 degrees is then

$$309.5 + 875.5 = 1185 \text{ B.t.u.}$$

Rule for Finding the Total Heat in Steam

What is the rule for finding the total heat in steam?

A. G.

To find the total heat in a pound of steam, subtract 32 from the temperature of the steam in degrees Fahrenheit, multiply the difference by 0.305, and add 1091.7 to the product. For example, take the case of 270-degree steam: 270 — 32 = 238; 238 × 0.305 = 72.59; 1091.7 + 72.59 = 1164.29 B.t.u.

To Calculate the Strength of Double Butt-strap Seams

Will you give me a rule or formula for calculating the strength of double butt-strap seams for boilers?

J. A. C.

In a perfect seam the strength of the plate along the line of the outer row of rivets is equal to the shearing strength of the rivets in one side of the seam. In practice the rivets are usually stronger than the sheet and the strength of the seam is the strength of the sheet along the outer row of rivets and is expressed by the formula,

$$\text{Strength} = \frac{\text{Pitch} - \text{Diameter of rivet hole}}{\text{Pitch}}.$$

This is a general statement.

To properly compute the strength of a boiler seam, the pitch, the diameter of the rivets, their shearing strength, the thickness of the plate and its tensile strength must be known. There are always two ways in which a boiler seam may fail; by the shearing of the rivets and by the tearing of the plate between the rivets. An analysis of the seams will show in which way it is most liable to fail, and from this a simple computation may be made of the probable strength of the seam.

To Calculate Horse-power When Using Back Pressure

Please tell me the correct way to calculate the horse-power of an engine when back pressure is used.

R. E. P.

Back pressure exists in all cases of engine running and is always a question of degree. In steam cylinders there is always pressure upon both sides of the piston and the difference between these pressures determines the power of the engine. In computing the work done in the cylinder, from the indicator diagram the mean effective pressure is found and the power developed is computed from it, and no attention whatever is paid to the atmospheric line.

Power Required by a Centrifugal Pump

Will a centrifugal pump require the same amount of power to lift water when it has a 2-foot suction and 28-foot discharge as with 12-foot suction and 18-foot discharge?

G. E. L.

It should not make much difference at what point in a column of water the power to move it is applied. Probably, if the pump were placed at or near the bottom of the column, slightly more water would be moved with the same expenditure of power than if placed at or near the top.

Ammonia Required to Charge a Compression System

How many drums of ammonia will it take to charge a compression-system ice machine of 25 tons capacity?

H. L.

While there is no absolutely fixed rule regarding the amount of ammonia for charging the compression ice-making system, the following may be considered in line with the average practice:

Tons of ice per 24 hours:					
5	10	15	25	50	100
Pounds ammonia:					
100	250	500	1000	2000	4000

Ammonia drums of usual size are rated at 100 pounds and actually hold from 100 to 110 pounds.

Packing for Ammonia Rod in Ice Machine

What kind of packing is best for the ammonia rod on a double-acting compressor (Linde)? Will rubber rings do?

C. C.

Pure gum-rubber rings are not suitable for ammonia-rod packing on account of the high coefficient of expansion. Slight changes in temperature cause the rubber to expand, putting undue pressure on the rod, which in turn causes the packing to burn. The oil used in lubricating ammonia rods is also very active in causing deterioration of pure rubber.

There are a number of kinds of ammonia packing on the market which will undoubtedly be suitable for packing a double-acting compressor rod. Different builders of refrigerating machines usually have a preference for some particular make of packing, and it might be well to consult the builders of the compressor; although we do not consider this absolutely necessary, as any conscientious supplyman will see that you are supplied with the kind of packing best adapted to your requirements. The principal point to observe in handling ammonia-rod packing is to maintain as nearly as possible a constant temperature in the ammonia rod, never putting any more pressure on the packing than is absolutely necessary to make it tight.

Why Blowing Off Does Not Lower Steam Pressure

If a boiler with three gages of water and 80 pounds steam pressure is blown down to one gage of water, why is it that the steam pressure does not drop, there being additional steam space in the boiler by about five inches?

E. M.

The boiling point of water is determined by the pressure which it is under. At the pressure of the atmosphere, or 14.72 pounds absolute, it boils at 212 degrees. At 80 pounds gage pressure, or 95 pounds absolute, it boils at 323.9 degrees, and at this temperature it would make no difference how much water was blown out of the boiler. As long as the water remaining in the boiler had a temperature of 323.9 degrees, it would give off steam and keep the pressure at 80 pounds. In POWER for November, 1907, and also in the weekly for March 17 and June 30, 1908, will be found interesting matter bearing on this subject.

Business Items

In order to look after the Southern territory the Ridgway Dynamo and Engine Company has concluded negotiations with the Machinery Sales Agency, at 1021 Prudential building, Atlanta, whereby it will handle its complete line of side and center crank engines, as well as direct-current electrical machinery.

We have received from A. L. Ide & Sons, of Springfield, Ill., a souvenir such as probably most engineers would be glad to get hold of. It is a pack of "Ideal" playing cards, joker and all, used to advertise the "Ideal" steam engines, half-tone views of which appear on the back of each card. The cards are of A-1 quality.

The Riverside Engine Company, Oil City, Penn., builder of the Riverside heavy-duty gas engine, has extended its sales organization by opening an office in the Rockefeller building, Cleveland, O., in charge of the Holbeck Company. The Riverside Company's shops have been running full time in spite of the recent financial depression.

The following officers of the Crocker-Wheeler Company, manufacturer and electrical engineer, of Ampere, N. J., were elected July 10: President, S. S. Wheeler; vice-president, Gano Dunn; second vice-president, A. L. Doremus; chief engineer, Gano Dunn; secretary, Rodman Gilder; treasurer, W. L. Brownell; assistant secretary, J. B. Milliken; assistant treasurer, G. W. Bower.

The H. W. Johns-Manville Company, 100 William street, New York City, recently placed on the market the "Success" portable fire extinguisher, which has the indorsement of the National Board of Fire Underwriters. The apparatus is simply turned bottom upward and the resultant mixture of sulphuric acid and charged water develops a chemical stream which smothers the fire.

The Du Bois Iron Works, Du Bois, Penn., has established agencies as follows: For the sale of gas and gasolene engines and producer gas plants, also steam and power pumps, Anderson & Gaylord, 1107 Real Estate Trust Building, Philadelphia, Penn.; General Supply Company, Independencia No. 28, Mexico, D. F.; Barden Electric Company, 109 Main street, Houston, Tex.; Hampson & Fielding, 1711 Tremont street, Denver, Colo.; A. C. Stansill, 5 Church avenue, Roanoke, Va.; B. S. Middleton, Goldsboro, N. C.; Cass Harkins & Son, 1419 Schofield building, Cleveland, O., and Geisendorff & Schlotxhauer, Indianapolis, Ind.

The L. S. Starrett Company announces that it has opened a warehouse at 36 and 37, Upper Thames street, London, E. C., England, with E. P. Barrus in charge, and will hereafter carry its fine mechanical tools, hack saws, steel tapes, etc., in stock at that place. The London branch will execute orders, render invoices and receive payments. The advantages of this arrangement to the British and Continental customers will be readily appreciated. Some of these advantages are a saving of three or four weeks in getting the goods; the goods will be brought freight-paid to London; the bills will be rendered in pounds, shillings and pence, and payments are to be made in London. Catalogs, with sterling prices, and discount sheets may be obtained at the above address.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—In every city live salesmen for money making steam trade specialty of established merit. Box 17, POWER.

WANTED—Salesmen on commission for New England, Southern and Western States for high grade shaking grates. Box 13, POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—Salesman on commission for high grade power specialties. Address, stating experience, Chas. T. Luce Co., 160 Congress St., Boston, Mass.

WANTED—Master mechanic for iron mine in northern Michigan. Must have had good experience with all kinds of mine machinery and machine shop work. To an energetic, capable man a good position is offered. If requested communications will be confidential. Address "iron," care of POWER, giving experience in detail, references and pay expected.

WANTED, AN ENGINEER—We handle all kinds of mechanical and electrical machinery; controlling the agencies of some of the best manufacturers in the United States and Canada for the province of Alberta and the Kootenay mining district in British Columbia. We have houses at Edmonton and Calgary, Alberta, and Nelson, B. C. We have a position open for an engineer who has practical experience in the above lines, and who also possesses ability as a salesman. This is a splendid opportunity for a capable young man wishing to get a start in the rapidly developing country of Northwestern Canada. Please state your age, experience, reference and salary required in your first letter. Address, Gorman, Clancey & Grindley, Limited, Calgary, Alberta, Canada.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

POSITION wanted by technical graduate with five years' practical erecting experience for large water tube boiler company. Prefer position in shops or sales. Box 11, POWER.

ENGINEER will pay $50.00 commission to anyone who secures or helps him secure a position as engineer, assistant engineer or station man in Rocky mountains or West. Box 14, POWER.

AN ELECTRICAL and steam engineer of nine years' experience is open for a position. Familiar with all kinds of engines, boilers, etc., and holds chief engineers' license; can handle any plant in d.c. or a.c. single and polyphase systems; married, and has No. 1 references. Box 16, POWER.

POSITION WANTED by a thoroughly competent and reliable engineer, who does not use liquor or tobacco. Twenty-eight years old, married, twelve years' experience with boilers, engines and machinery; understands electricity and its manipulation from the generator to the lamp or motor, a.c. or d.c. Is a graduate from the I. C. S. ,steam-electric course, and from the coal scoop. Owns indicator and drawing outfit. Would like position as chief or assistant in electric plant in South or West. Not out of a job, but wants to change. Box 15, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-Examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24 in. face. F. W. Iredell, 11 Broadway, New York.

FOR SALE—Foundry, machine and carpentry shops, with government concession for twenty years, at Hermosillo, Mexico. Box 18, POWER.

FOR SALE—Buckeye engine, 150 to 175 h.p., good as new, great bargain for cash. Can be seen in operation. Address No. 1001 Arcade Bldg., Philadelphia, Pa.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—The patent rights of one of the best steam traps and oil filters manufactured. A bargain if sold quickly. Parties reason for selling being the desire to retire from business. Box 85, POWER.

FOR SALE—Six 300-h.p. Babcock & Wilcox boilers arranged in batteries of two 300-h.p. boilers each. Will be sold immediately to the highest bidder, subject to the inspection of the purchaser. Address Louisville Lighting Company, 14th and Magazine Sts., Louisville, Ky.

FOR SALE—Territory rights to manufacture a metallic packing with an established reputation. Highly recommended by all users. Equipment costs very little. Excellent opportunity for hustlers in all manufacturing districts. Very favorable terms. Also own foreign patents. Box 7, POWER.

MACHINERY FOR SALE at the Kokomo, Indiana, works of the Pittsburgh Plate Glass Company. One L. H. 30x60 E. P. Allis girder frame Corliss engine, 24' fly-wheel; 1 L. H. 10x30 E. P. Allis girder frame Corliss engine, 12' fly-wheel; 1 G. F. Blake 9x20x12 duplex vertical air pump; 1 E. P. Allis vertical surface condenser, 2700 sq.ft.; 1 15x18 high speed piston valve Beck engine; 1 10x18x14 tandem compound self-oiling Fisher automatic engine; 1 14x10x12 Smith-Vaile duplex steam pump; 1 R. H. Rankin & Fritsch 14x20 Tangye frame slide valve engine; 1 L. H. Rankin & Fritsch 14x20 Tangye frame slide valve; 1 13x20 box bed R. H. Mansfield throttling engine; 1 12x20 box bed L. H. Mansfield throttling engine; 7 14x24 Atlas box bed slide valve engines L. H.; 7 14x24 Atlas box bed slide valve engines, R. H.; 1 Laidlaw-Dunn-Gordon 14x22x18 duplex air compressor; flywheel-type air cylinder, unjacketed; 1 Dean Steam Pump Co. 12x7x10 duplex pump, just out of repair shop; 1 6x4x6 Worthington duplex steam pump; 1 Dean Steam Pump Co. 10x6x10 duplex steam pump; 8 Cahall vertical water tube safety boilers, 250 h.p. each. Inquire about above of W. D. Hartupee, 2d Vice Pres., Pittsburgh Plate Glass Co., Frick Building, Pittsburg, Pa.

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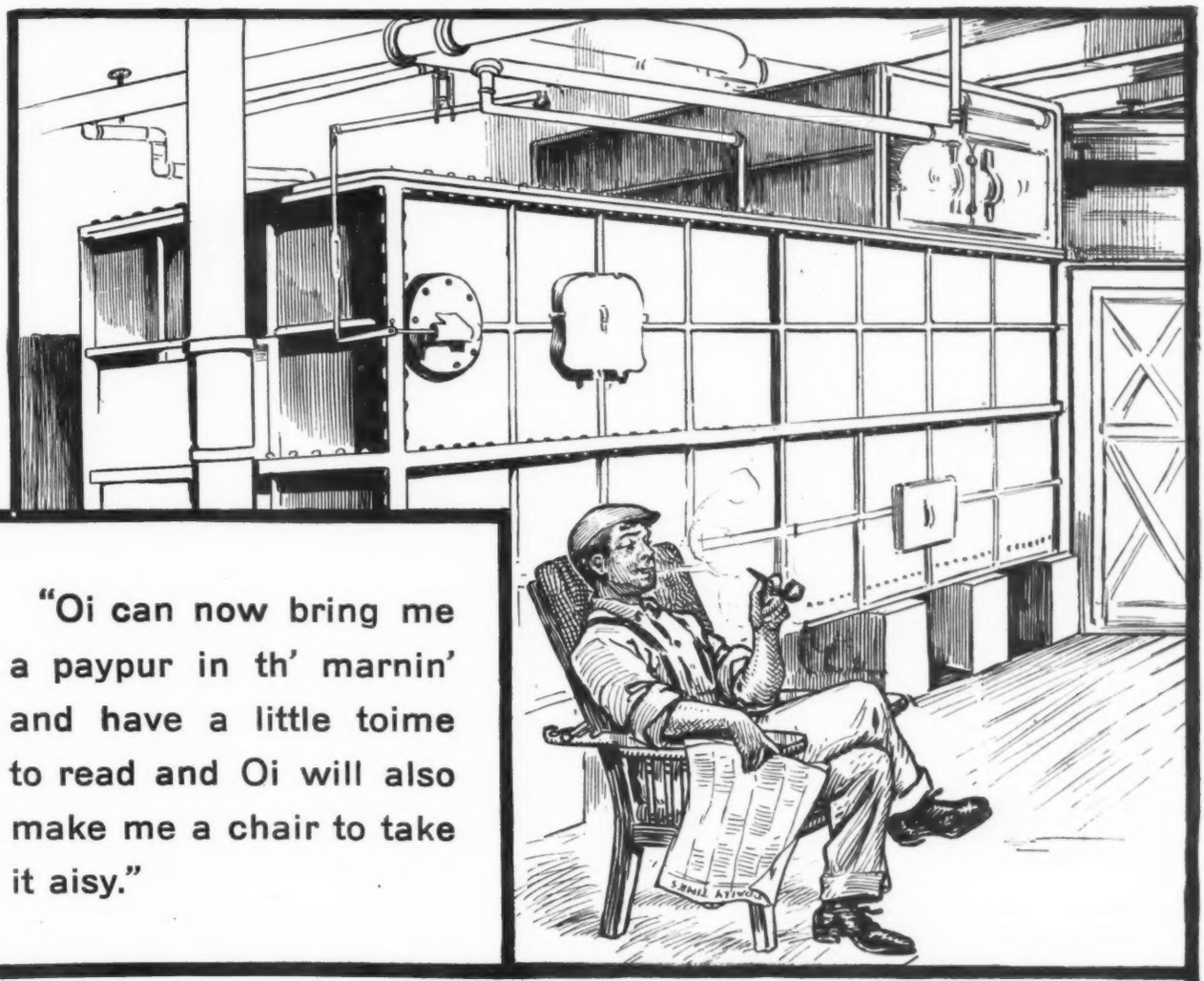
American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Text Book Co., Scranton, Pa.



"Oi can now bring me a paypur in th' marnin' and have a little toime to read and Oi will also make me a chair to take it aisy."

Said the fireman after we had put our Hot Process System of Water Softening in operation. The fireman had been using cold, hard water all day, for boiler feed, passing it through an old closed heater, and found it hard to keep up 40 lbs. steam pressure, but when the soft water at 211° F. from our Hot Process System was turned into the boilers, it was necessary to close the damper partly and to shut the draft doors of the boilers, and even then the pressure still ran up.

Water should always be fed to the boilers hot, and, if it deposits scale in the boilers, it should also be softened. Our Hot Process System combines the functions of heater and softener in one apparatus, thereby saving a large percentage of the combined cost of a heater and a cold process softener. Moreover, by combining heat treatment with chemical treatment, one of the chemicals used with all cold processes is rendered unnecessary.

Our Hot Process Softening apparatus further saves the cost of return and muffle tanks, independent oil separator, raw water regulator, auxiliary tank and one or more steam traps. All steam condensed in the process of heating the water is conserved as pure distilled water, thus saving the cost of buying and softening that much raw water.

Write us about your plant. Perhaps we can make valuable suggestions. Our engineers have had extensive experience in the utilization of exhaust steam in condensing and non-condensing steam plants, heating buildings, drying materials, producing hot water for laundries, leather factories, paper mills, railway round houses, etc.

HARRISON SAFETY BOILER WORKS,

17th AND CLEARFIELD STS., PHILADELPHIA, PA.

Building Materials, Fireproof

Carey Co., The, Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.

Castings, Brass and Iron

Homestead Valve Mfg. Co., Pittsburg, Pa.
McClave-Brooks Co., Scranton, Pa.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Castings, General

Neemes Bros., Troy, N. Y.

Castings, Malleable

Jeffrey Mfg. Co., Columbus, O.

Cement, Asbestos

Johns-Manville Co., H. W., New York.
N. Y. Belting & Packing Co., New York.

Cement, Boiler

Smooth-On Mfg. Co., Jersey City, N. J.

Chain Blocks

Yale & Towne Mfg. Co., New York.

Chimneys, Steel Concrete

Weber Co., The, Chicago, Ill.

Clamps, Steam Joint

McCrea & Co., James, Chicago, Ill.

Cleaners, Boiler Tube

Buckeye Boiler Skimmer Co., Toledo, Ohio.
Monarch Steam Blower Co., Troy, N. Y.
Garlock Packing Co., Palmyra, N. Y.
General Specialty Co., Buffalo, N. Y.
Scully Steel & Iron Co., Chicago, Ill.
Stewart Heater Co., Buffalo, N. Y.

Clocks, Engine Room

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Clutches, Friction

Williams Fdry. & Mach. Co., Akron, Ohio.

Coal and Ash Handling Machinery

Bartlett & Snow Co., C. O., Cleveland, O.
Jeffrey Mfg. Co., Columbus, O.

Cocks, Blow-Off

Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Cocks, Gauge

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Huyette Co., P. B., Philadelphia, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Reliance Gauge Column Co., Cleveland, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

Cocks, Steam

Homestead Valve Mfg. Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, O.

Compound, Boiler

Bird-Archer Co., New York.
Buckeye Boiler Skimmer Co., Toledo, Ohio.
Dearborn Drug & Chemical Co., Chicago, Ill.
Hawk-Eye Compound Co., Chicago, Ill.
Johns-Manville Co., H. W., New York.

Compound, Lubricating

Cook's Sons, Adam, New York.

Condensers

Alberger Condenser Co., New York.
American Steam Pump Co., Battle Creek, Mich.
Baragwanath & Son, Wm., Chicago, Ill.

Condensers—*Continued.*

Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Schutte & Koerting Co., Philadelphia, Pa.
Stewart Heater Co., Buffalo, N. Y.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Union Steam Pump Co., Battle Creek, Mich.
Wheeler Condenser and Engineering Co., New York.

Consumers, Smoke

Climax Smoke Preventer Co., Boston, Mass.

Controllers, Electric

General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa

Cooling Towers

Alberger Condenser Co., New York.
Baragwanath & Sons, Wm., Chicago, Ill.
Wheeler Condenser and Engineering Co., New York.

Correspondence Schools

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa,

Couplings, Clutch

Williams Fdry. & Mach. Co., Akron, Ohio

Covering, Pipe and Boiler

Carey Co., The Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.
U. S. Mineral Wool Co., New York.

Cranes

Yale & Towne Mfg. Co., New York.

Die Stocks

Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Loew Mfg. Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.

District Steam Heating

American District Steam Co., Lockport, N. Y.

Draft, Mechanical

Green Fuel Economizer Co., Matteawan, N. Y.

Drills, Upright

Barnes Co., W. F. & Jno., Rockford, Ill.

Dynamos and Motors, Alternating Current

C & C Electric Co., The, New York.
Clark Bros. Co., Belmont, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Dynamos and Motors, Direct Current

C & C Electric Co., The, New York.
Crocker-Wheeler Co., Ampere, N. J.
Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Triumph Electric Co., Cincinnati, O.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Economizers, Fuel

Green Fuel Economizer Co., Matteawan, N. Y.

Ejectors

Beggs & Co., Jas., New York.
Desmond-Stephan Mfg. Co., Urbana, Ohio.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.

Electrical Engineers

Crocker-Wheeler Co., Ampere, N. J.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Northern Electrical Mfg. Co., Madison, Wis.

Electrical Supplies

General Electric Co., Schenectady, N. Y.
Johns-Manville Co., H. W., New York.
Ohio Brass Co., Mansfield, Ohio.

Engineers, Consulting and Contracting

Illmer & Co., Cincinnati, Ohio.

Engineers' Supplies

Mound Tool & Scraper Co., St. Louis, Mo.

Engines, Corliss

Bates Machine Co., Joliet, Ill.
Beggs & Co., Jas., New York.
Cooper Co., C. & G., Mt. Vernon, O.
Griffith & Wedge Co., Zanesville, O.
Ide & Son, A. L., Springfield, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Providence Eng. Works, Providence, R. I.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Watertown Engine Co Watertown, N. Y.
Wetherill & Co., Robert, Chester, Pa.

Engines, Gas and Gasolene

Alberger Co., A. H., Buffalo, N. Y.
De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Fort Wayne Fdry. & Mach. Co., Fort Wayne, Ind.
Illmer & Co., Cincinnati, Ohio.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Struthers-Wells Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, High Speed

American Diesel Engine Co., New York.
American Engine Co., Bound Brook, N. J.
Ball Engine Co., Erie, Pa.
Bates Machine Co., Joliet, Ill.
Clark Bros. Co., Belmont, N. Y.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Eng. Co., Fitchburg, Mass.
Ide & Son, A. L., Springfield, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Reeves Engine Co., Trenton, N. J.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Philadelphia, Pa.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Medium and Low Speed

American Diesel Engine Co., New York.
Ball Engine Co., Erie, Pa.
Brown Engine Co., C. H., Fitchburg, Mass.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Ide & Son, A. L., Springfield, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Reeves Engine Co., Trenton, N. J.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Mach. Co., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Oil

American Diesel Engine Co., New York.
De La Vergne Machine Co., New York.

Engines, Rotary

Ball-Cooley Engineering Co., New York.

Exhaust Heads

Burt Mfg. Co., Akron, O.
Gardner Gov. & Separator Co., Quincy, Ill.
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Experts, Chemical

Hunt & Co., Robt. W., Chicago, Ill.

Fans, Electric

Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.

Fans, Exhaust and Ventilating

Ohio Blower Co., Cleveland, O.
Sirocco Engineering Co., New York.

Fans, Mine Vetilating

Jeffrey Mfg. Co., Columbus, O.

Feed Water Filters

Beggs & Co., Jas., New York.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Keystone Chemical Co., Philadelphia, Pa.
Northern Water Softener Co., Madison, Wis.

Feed Water Heaters and Purifiers

Alberger Condenser Co., New York.
Baragwanath & Son, Wm., Chicago, Ill.
Bates Machine Co., Joliet, Ill.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Erie Mfg. & Supply Co., Erie, Pa.
Goubert Mfg. Co., New York.
Griscom-Spencer Co., New York.
Harrison Safety Boiler Wks., Philadelphia, Pa.
Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.
Hoppes Mfg. Co., Springfield, O.
Kewanee Boiler Co., Kewanee, Ill.
Loew Mfg. Co., Cleveland, O.
National Pipe Bending Co., New Haven, Conn.
Patterson & Co., F. L., New York.
Stewart Heater Co., Buffalo, N. Y.
Webster & Co., Warren, Camden, N. J.
Wheeler Condenser and Engineering Co., New York.
Whitlock Coil Pipe Co., Hartford, Conn.
Wickes Boiler Co., Saginaw, Mich.

Filters, Oil

Burt Mfg. Co., Akron, O.
Liberty Mfg. Co., Pittsburg, Pa.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Fire Brick

C-O-Two Furnace Co., Syracuse, N. Y.
McLeod & Henry Co., Troy, N. Y.
Presbrey Fire Brick Co., Taunton, Mass.

Fittings, Hydraulic

Watson-Stillman Co., New York.

Fittings, Pipe

Triumph Ice Machine Co., Cincinnati, Ohio.
Ohio Brass Co., Mansfield, O.

Fittings, Steel

Nelson Valve Co., Philadelphia, Pa.

Fittings, Steel Pipe

Nelson Valve Co., Philadelphia, Pa.

Flanges

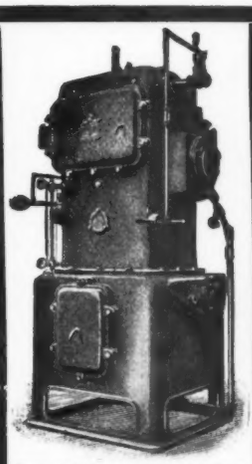
Central Station Steam Co., Detroit, Mich.
Scully Steel & Iron Co., Chicago, Ill.

Flange Fittings, High or Low Pressure

Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
Pittsburg Valve & Fittings Co., Barberton, O.
Pittsburgh Valve, Foundry & Construction Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

IF "thoroughfare" heaters were the only ones on the market, there'd be some excuse for using them. They are better than none. But when you can just as well have a *Webster* and *Webster* economy—well the conclusion is obvious.

The Webster Feed Water Heater, Purifier and Filter.



THE WEBSTER FEED-WATER HEATER AND PURIFIER.

Two and A Quarter Million Horse Power In Use.

THIS Heater is not a runway for exhaust steam. It takes the exhaust because it needs it, takes as much as it needs, and not a bit more. The water is broken up into minute globules and brought into intimate contact with the steam. That the water is heated to the highest possible temperature by a minimum amount of steam is an obvious fact.

The "thoroughfare" principle allows waste; the Webster prevents it. That's the point for the man who pays the bills to consider. Webster appliances work for economy—are they working for you?

Write us for booklet 12-F.

Warren Webster & Co.,

Camden, New Jersey.

Floats

Anderson Co., V. D., Cleveland, O.
Reliance Gauge Column Co., Cleveland, O.

Forges

Scully Steel & Iron Co., Chicago, Ill.

Furnace Tile

C-O-Two Furnace Co., Syracuse, N. Y.

Furnaces

Continental Iron Works, Brooklyn, N. Y.
Murphy Iron Works, Detroit, Mich.

Furnaces, Smokeless

McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Wilkinson Mfg. Co., Bridgeport, Penn.

Gaskets

American Goetze Gasket & Packing Co., New York.
Brandt, Randolph, New York.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Jenkins Bros., New York.
Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
N. Y. Belting & Packing Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Smooth-On Mfg. Co., Jersey City, N. J.
U. S. Mineral Wool Co., New York.

Gaskets, Copper

Central Station Steam Co., Detroit, Mich.
Restein Co., Clement, Philadelphia, Pa.
U. S. Mineral Wool Co., New York.

Gauge Testing Outfit

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Gauges

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Bristol Co., The, Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.
Huyette Co., Paul B., Philadelphia, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Gauges, Ammonia

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Gauge Glasses

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Garlock Packing Co., Palmyra, N. Y.
Sterling Lubricator Co., Rochester, N. Y.

Gauges, Pressure

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh Pa.
Williams Valve Co., D. T., Cincinnati, O.

Gauges, Recording

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Gauges, Vacuum

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Gauges, Water

Ohio Brass Co., Mansfield, O.
Safety Equipment Mfg. Co., Chicago, Ill.

Generating Sets

American Engine Co., Bound Brook, N. J.
Crocker-Wheeler Co., Ampere, N. J.
C. & C. Electric Co., New York.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Skinner Engine Co., Erie, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Generating Sets—*Continued.*

Watertown Engine Co., Watertown, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Governors, Inertia

Ide & Son, A. L., Springfield, Ill.

Governors, Pump

Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Indianapolis, Ind.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Iowa.
Gardner, Governor & Separator Co., Quincy, Ill.
Safety Equipment Mfg. Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.

Grates

Gibson Iron Wks. Co., Jersey City, N. J.
Green Engineering Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., Chicago, Ill.

Grates, Clinker Cutting

Neemes Bros., Troy, N. Y.

Grates, Shaking and Dumping

Gibson Iron Wks. Co., Jersey City, N. J.
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.

Grates, Stationary

Gibson Iron Wks. Co., Jersey City, N. J.
Neemes Bros., Troy, N. Y.

Grease

Cook's Sons, Adam, New York.
Keystone Lubricating Co., Philadelphia, Pa.
New York & New Jersey Lubricant Co., New York.

Heating and Ventilating Apparatus

Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.
Webster & Co., Warren, Camden, N. J.

Hose, Air and Oil

Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Hose, Rubber

Bowers Rubber Wks., Oakland, Cal.

Hose, Steam and Water

Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Indicators, Ammonia

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Gas Engine

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Hydraulic

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Speed

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Starrett Co., L. S., Athol, Mass.

Indicators, Steam Engine

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lippincott Steam Specialty and Supply Co., Newark, N. J.
Robertson & Sons, James L., New York.
Trill Indicator Co., Corry, Pa.

Indicators, Valve

Safety Equipment Mfg. Co., Chicago, Ill.

Injectors

American Injector Co., Detroit, Mich.
Desmond-Stephan Mfg. Co., Urbana, Ohio.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Randle Mach. Co., Cincinnati, O.
Schutte & Koerting Co., Philadelphia, Pa.

Insulation

Johns-Manville Co., H. W., New York.

Jacks, Hydraulic

Watson-Stillman Co., New York.

Joints, Expansion

Central Station Steam Co., Detroit, Mich.

Lamps, Arc and Incandescent

Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Locks

Yale & Towne Mfg. Co., New York.

Lubricants

Cook's Sons, Adam, New York.
Dearborn Drug & Chemical Wks., Chicago, Ill.
Dixon Crucible Co., Jos., Jersey City, N. J.
Keystone Lubricating Co., Philadelphia, Pa.
New York & New Jersey Lubricant Co., New York.

Lubricators

Cook's Sons, Adam, New York.
Detroit Lubricator Co., Detroit, Mich.
Greene, Tweed & Co., New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Lubricator Co., Wadsworth, O.
Philadelphia Lubricator & Mfg. Co., Philadelphia, Pa.
Sterling Lubricator Co., Rochester, N. Y.

Machinery, Conveying

Bartlett & Snow Co., C. O., Cleveland, O.
Jeffrey Mfg. Co., Columbus, O.

Machinery, Crank Pin Turning

Underwood & Co., H. B., Philadelphia, Pa.

Machinery, Ice and Refrigerating

De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, Ohio.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

Machinery, Second Hand

Randle Mach. Co., Cincinnati, O.

Machines, Portable Milling

Underwood & Co., H. B., Philadelphia, Pa.

Machines, Valve Reseating

Leavitt Mach. Co., Orange, Mass.

Mats and Matting

Mercer Rubber Co., Hamilton Square, N. J.

Mechanical Draft Apparatus

Green Fuel Economizer Co., Matteawan, N. Y.

Mechanical Stokers

Westinghouse Machine Co., Pittsburg, Pa.
Wilkinson Mfg. Co., Bridgeport, Pa.

Meters, Steam

St. John, G. C., New York.

Meters, Water

Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.

Metal Polish

Hoffman, Geo. W., Indianapolis, Ind.

Oil Burners

Hammel Oil Burner Co., Los Angeles, Cal.

Oil and Grease Cups

Cook's Sons, Adam, New York.
Greene, Tweed & Co., New York.
Keystone Lubricating Co., Philadelphia, Pa.
Lunkenheimer Co., The, Cincinnati, O.
New York & New Jersey Lubricant Co., New York.
Philadelphia Lubricator & Mfg. Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, O.

Oilers

Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Oiling Systems

Burt Mfg. Co., Akron, O.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Oils

Cook's Sons, Adam, New York.
Dearborn Drug & Chemical Wks., Chicago, Ill.
New York & New Jersey Lubricant Co., New York.

Oils, Non Fluid

New York & New Jersey Lubricant Co., New York.

Packing, Asbestos

Diamond Rubber Co., Akron, Ohio.
Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
Restein Co., Clement, Philadelphia, Pa.

Packing, Flange

American Goetze Gasket & Packing Co., New York.
Brandt, Randolph, New York.
Carey Co., The Philip, Cincinnati, O.
Diamond Rubber Co., Akron, Ohio.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Jenkins Bros., New York.
Johns-Manville Co., H. W., New York.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Phila., Pa.
Restein Co., Clement, Phila., Pa.
Sayen, Osgood, Philadelphia, Pa.
Vanda Co., New York.

Packing, Hydraulic

Brandt, Randolph, New York.
Detroit Leather Specialty Co., Detroit, Mich.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Phila., Pa.
Restein Co., Clement, Phila., Pa.
Robertson & Sons, Jas. L., New York.
Sayen, Osgood, Philadelphia, Pa.
Steel Mill Packing Co., Detroit, Mich.
Vanda Co., New York.

Packing, Metallic

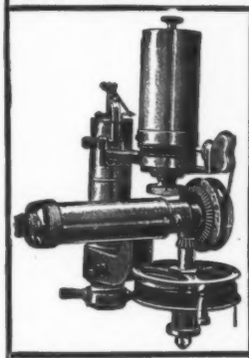
American Goetze Gasket & Packing Co., New York.
Bowers Rubber Wks., Oakland, Cal.
Canfield Mfg. Co., Philadelphia, Pa.
France Packing Co., Philadelphia, Pa.

Oster No. 300-A Power Pipe and Nipple Machine

We want this machine in your shop, because it will again prove to you that we sell you Oster quality, worth all we ask. A satisfied customer is our bread and butter.

THE OSTER MFG. COMPANY,
21 Schiely Street, Cleveland, Ohio, U. S. A.

THERE IS BUT ONE **BEST INDICATOR**



The Crosby Indicator
(with either inside or outside spring)

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With CROSBY REDUCING WHEEL
IS A PERFECT COMBINATION

In Making IMPORTANT TESTS of power plants IT IS THE ONE relied upon

NO ENGINEER should risk his REPUTATION with any other instrument

Highest Awards at all World Fairs

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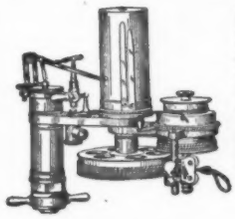

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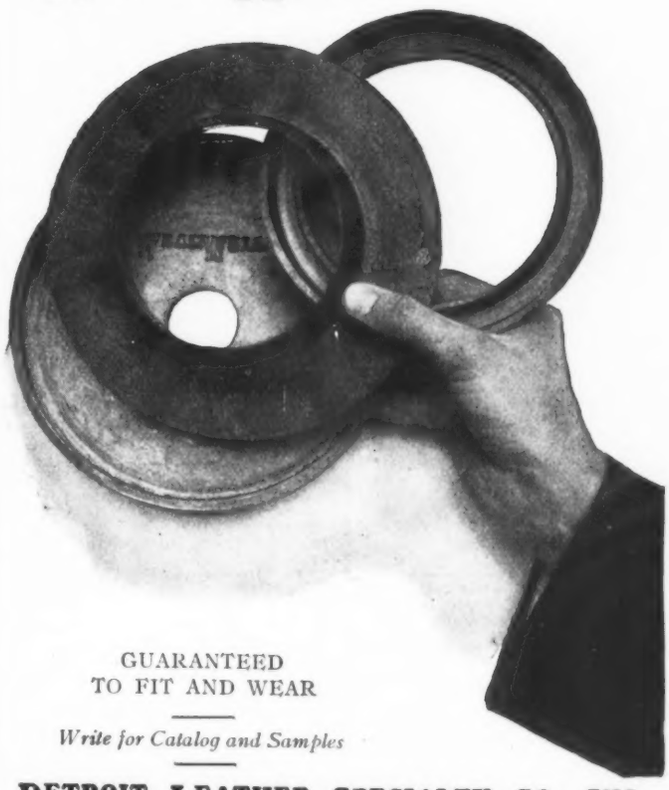

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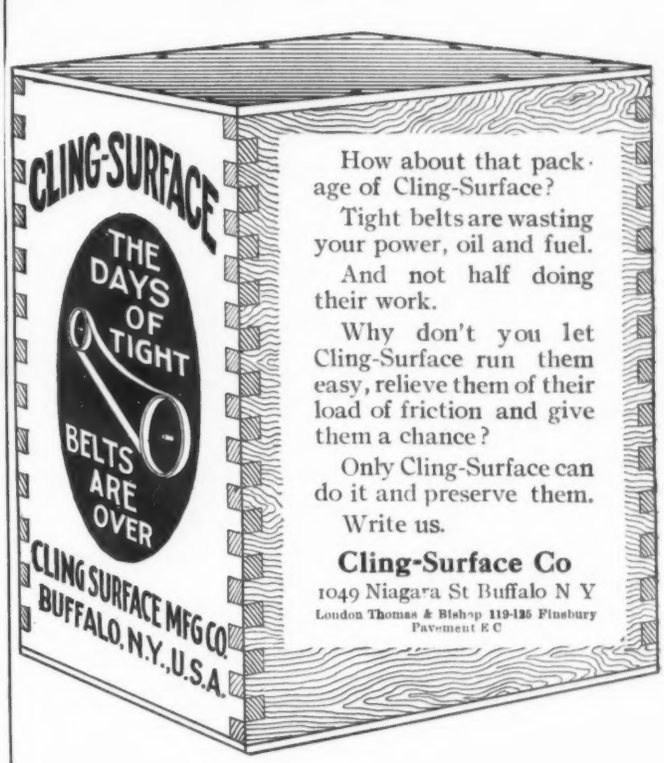

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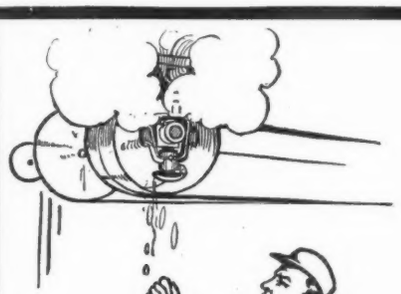

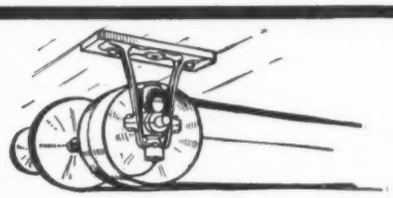

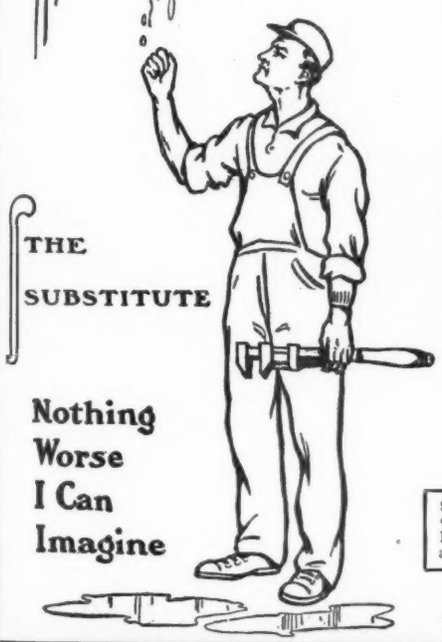

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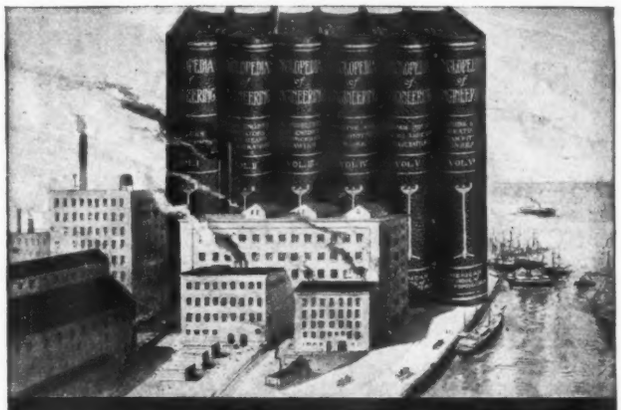

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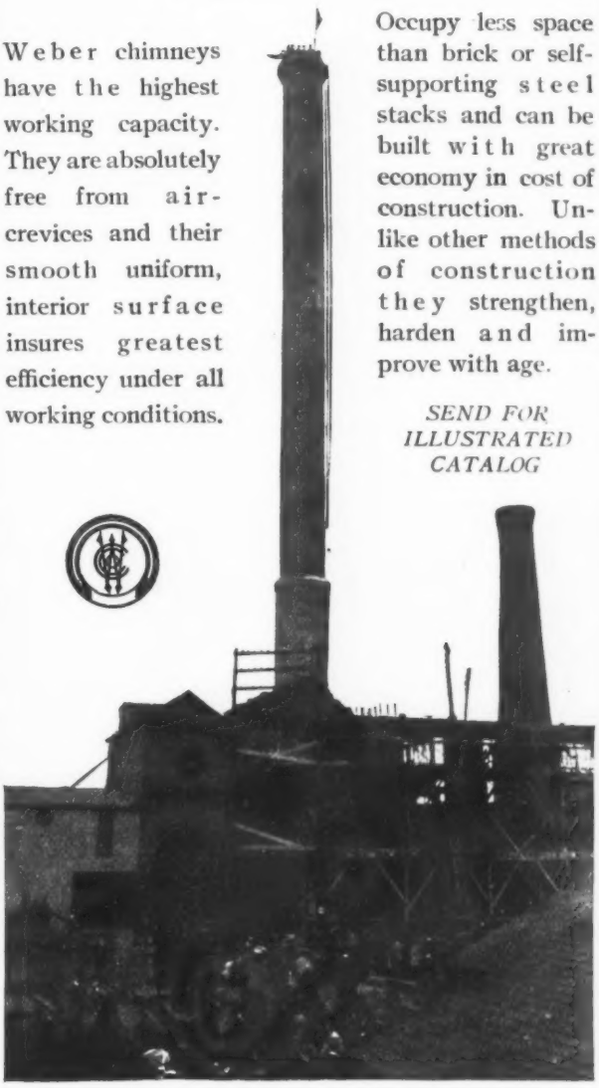

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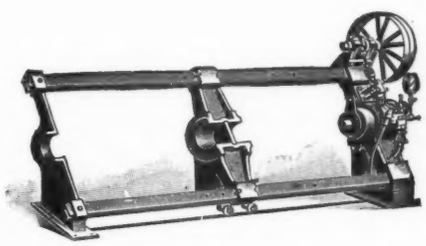

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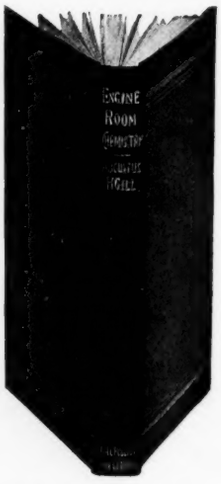

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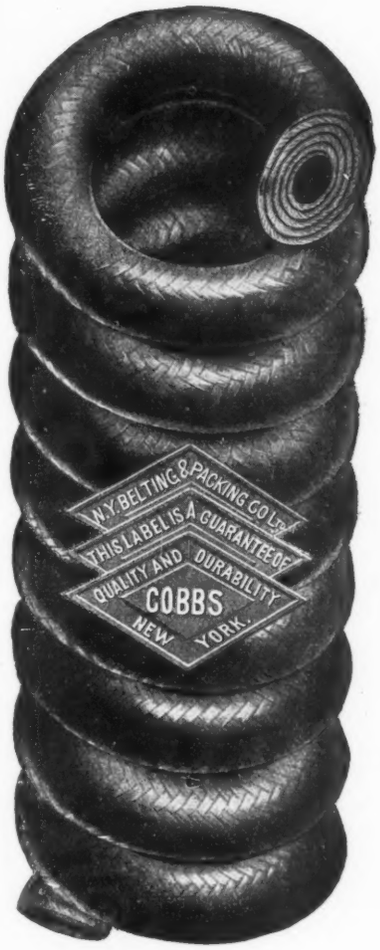

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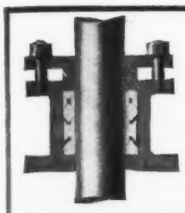

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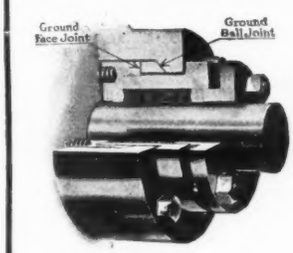

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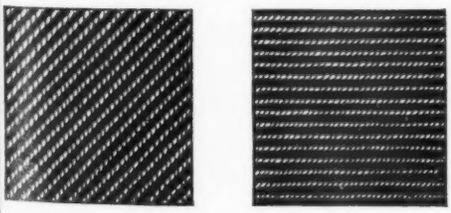

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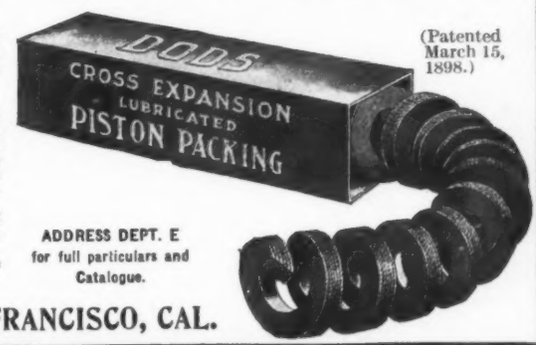

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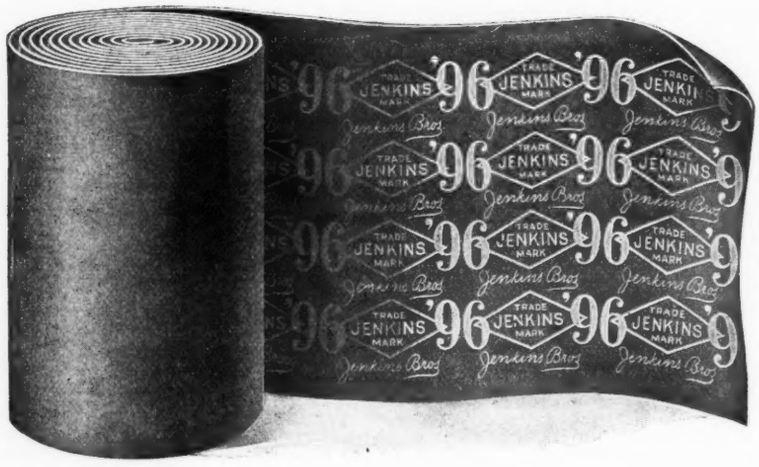

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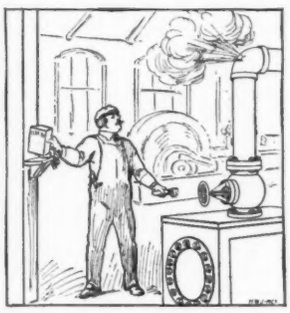


It is, in reality, a powdered iron. When mixed with water and applied like putty to cracks, spongy spots, sand holes or blow holes in iron or steel, it makes a permanent repair that looks just like the iron itself. Is not affected by any heat, acid, gas or oil that iron will stand, and will hold any pressure up to 1,000 pounds.

Should be in every plant. Saves shut-downs—saves many articles from the scrap heap.

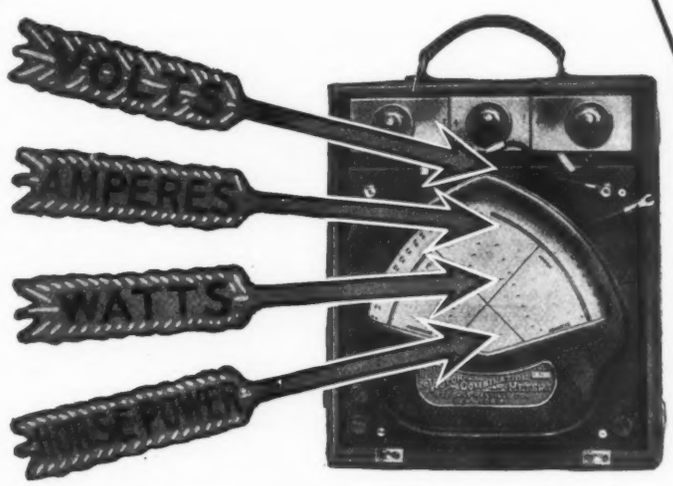
—

Write Nearest Branch for Booklet

The Victor Combination Meter

Gives 4 Readings At Once

Tells at a glance the voltage, current, power consumed in kilowatts, and the horsepower consumption on any direct current circuit.



Accomplishes the results of three meters. Is substantial in construction, permanent in calibration, requires a minimum of energy to operate, is dead beat, unaffected by temperature variations, and beautifully finished. Made in two types—Portable and Switchboard. **Write nearest Branch for Catalog 404.**

Stop Breaking Gauge Glasses!

The GILBERT GAUGE GLASS PRESERVER positively prevents gauge glasses breaking. When a gauge cock is once packed, it stays packed.

No lost time replacing gauge glasses.

No danger of scalding operators or of shut-downs and delays.

One GILBERT GAUGE GLASS PRESERVER saves many dollars' worth of gauge glasses.

—

Write Nearest Branch for Booklet

H. W. JOHNS-MANVILLE CO.

Manufacturers of Asbestos and Magnesia Products, Asbestos Roofings, Packings, Electrical Supplies, Etc.

New York	St. Louis	Baltimore	Los Angeles
Milwaukee	Pittsburg	New Orleans	Seattle
Chicago	Cleveland	Kansas City	Dallas
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(825-727-816)

They Fit The Roughest Surfaces

making them just as secure as any other gaskets could make the finest of machined flanges.

Goetze's Copper Gaskets

are used by the million simply because they will pack any sort of joint securely and keep it tight for years under any pressure or any degree of superheat. Write for a free trial gasket.

American Goetze-Gasket and Packing Company

525 E. 149 Street - - New York

VANDA

A STEAM PACKING THAT IS A STEAM PACKING

TRADE MARK. REG. IN U. S. PAT. OFF.

All Goods Stamped with the VANDA TRADE-MARK will fulfill the claims we make for them.

VANDA SHEET PACKING

THIS PACKING IS THE PIONEER OF ALL COMPOSITION PACKINGS, AND IMITATORS ARE APPEARING IN GREAT NUMBERS. WE THEREFORE, WOULD ESPECIALLY CALL YOUR ATTENTION TO OUR

TRADE-MARK DEVICE STAMPED ON EVERY SHEET

GOODS MADE IN SHEETS ONLY OF 4½' x 4½' AND 4½' x 9', IN ALL THICKNESSES

THE VANDA COMPANY, 96 SPRING STREET, N. Y.

H. W. JOHNS-MANVILLE CO., CO-DISTRIBUTORS

BELMONT
"1903"
EXPANSION PACKING

For Steam and Ammonia

Pat. Feb. 24, 1903.

See the sliding wedge ?

When you place a ring in the stuffing box pull the ends of one wedge ahead of the casing ends, and push the other one back, then when the ring is closed and ready for service the joint is divided into three breaks, occurring at different points on the circumference. This feature enables one ring of **Belmont 1903 Expansion Packing** to stop steam as effectively as three rings of ordinary packing, and makes it especially valuable for shallow stuffing boxes. Material throughout is the best obtainable, and **Belmont 1903 Expansion Packing** (fully described in booklet A) is guaranteed for any service with steam or ammonia up to 125 lbs. pressure. Above this pressure our "high pressure" packing (write for booklet B) is to be preferred. *General Catalog on Request.*

FREE!

Send for a sample ring and be convinced.

CLEMENT RESTEIN CO.,
Philadelphia, Pa.

Gentlemen:—
Send me a sample ring of Belmont 1903 Expansion Packing

Name.....
Address.....
Firm Name.....
Number of Engines.....
Number of Pumps.....
Number of Boilers.....
High or Low Pressure.....
Packing now in use.....

Power, 7-7-08.

CLEMENT RESTEIN COMPANY

133 North Second St. PHILADELPHIA, PA.

There are Other Eureka Packings

Besides the well-known GUM CORE we are also manufacturing large quantities of Eureka Cut Ring, High Pressure, Water Proof and Red Sheet.

ASK YOUR DEALER FOR GENUINE EUREKA

THIS LABEL ON PACKING
"EUREKA"
TRADE MARK.
IS A GUARANTEE OF EXCELLENCE.

Cut Rings
and in Spiral Form

is the same in quality as our famous Eureka Gum Core. Guaranteed equal to any ring packing on the market.

High Pressure
in Coils and Rings

Finest material, treated by our process, makes this packing practically indestructible.

Water Proof
in Coils and Rings

Made of pure long line flax specially treated to make it most efficient for all hydraulic uses.

Red Sheet

Sold under an absolute quality guarantee. None better can be made.

Our Prices and Delivery will interest you. Write for them.

Eureka Packing Co.

Jas. L. Robertson, Pres.

46 Warren Street, New York

"Torpedo-Asbestos"

HIGH PRESSURE SHEET PACKING

Now used extensively by the leading shipyards in the United States.

Style No. 1050—U. S. N. Special, for high pressure and superheat.
Style No. 1060—Best Commercial, Soft, flexible, good for all-round work.

Don't Experiment with packings. Use something you are *sure* will do your work. **TORPEDO-ASBESTOS** won its reputation on U. S. Navy torpedo boats

Write for our Catalog

Send in your orders for all kinds of Engine Room supplies.

Asbestos Metallic Steam Sheet Packing, about 250 lbs. to roll, 40 in. wide, all thicknesses.

Osgood Sayen Main Office, 421 Arcade Bldg. 15th & Market Sts., Philadelphia, Pa.
Store and Warerooms, 131 Market St., Philadelphia.

If Uncle Sam *should* have to fight
The tricky little Jap,
He'll surely wipe those Islanders
Completely off the map.
He's got the ships, the cash, the men,
He's got *Black Squadron* too;
So, over there, they'd best beware,
The old *Red, White,* and *Blue.*

BLACK SQUADRON

(THE ORIGINAL SLIDING WEDGE PACKING)

Gives greatest rod pressure, with least friction. Cannot carbonize and score the rod. Remains pliable under all conditions. Will not "melt away" in the stuffing box. Outwears all others.

Booklet on Request.

CANCOS MANUFACTURING CO.,
Philadelphia, Pa.
10 Oliver St., Boston, Mass. 525 Third Ave., Pittsburg, Pa. 805 Plowman St., Baltimore, Md.

Carey's 85 per cent Carbonate Magnesia Coverings

THE largest contract ever awarded for steam pipe and boiler coverings specified Carey's. This was the result of an exhaustive test conducted by the Manhattan Railway Company of New York, which proved Carey's Coverings to be more efficient and far superior in every way to any other of the numerous makes. No other coverings proved to be as light, clean and substantial.

Carey's Coverings are absolutely fire-proof, and being thorough non-conductors of heat they confine the heat to the pipes, effectually preventing its loss through radiation, thus saving in fuel an amount sufficient to *more* than offset the cost of their application.

The most prominent steam users everywhere use Carey's Covering. Do you want to know why?

Send for Carey's Magnesia Catalogue. It gives information not obtainable elsewhere.

THE PHILIP CAREY COMPANY

General Offices: Station R, Cincinnati, O.
FACTORIES: Lockland, Ohio; Plymouth Meeting, Pa.
Branches and Warerooms:

New York: 114-118 Liberty Street.
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Buffalo, N. Y.: 45 Pearl Street.
Pittsburg, Pa.: 333-335 Second Avenue.
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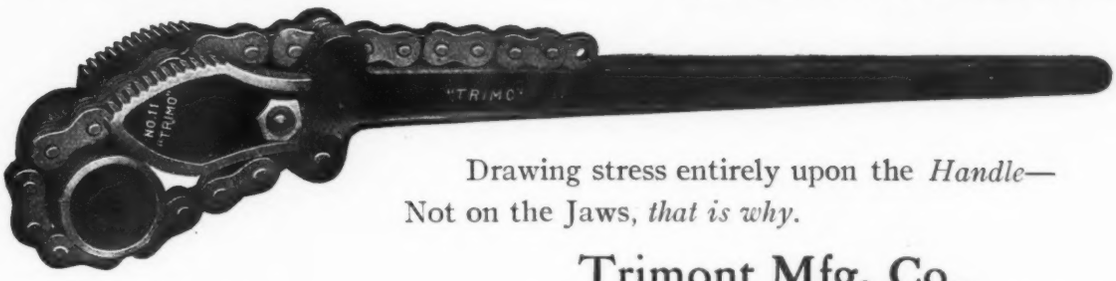
Charlotte, N. C.: East 7th and R. R. Streets.
New Orleans, La.: 222 Chartres Street.

"Trimo"

Strongest of All Chain Wrenches

Gold Medal St. Louis, 1904



Drawing stress entirely upon the *Handle*—
Not on the Jaws, *that is why.*

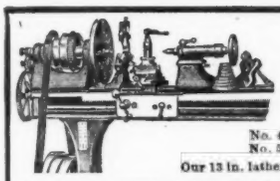
Sent free
New Catalogue No. 21. Write for one.

Trimont Mfg. Co.,
55-71 Amory St., Roxbury, Mass., U. S. A.

As Sure To Operate As The Law of Gravity

The Morehead Non-Return Steam Traps operate simply by gravity and cannot fail to deliver all the condensation from any system.
CATALOG ON REQUEST

Morehead Manufacturing Co., 1051 Grand River Ave., Detroit, Mich.



"The BARNES"
LATHES
W.F. AND J.C.
9 in. to 13 in. Swing.
No. 4½ Lathe, 9 in. x 25 in., List $ 75.00
No. 5 Lathe, 11 in. x 34 in., List 100.00
Our 13 in. lathes made 5 to 10 feet long. Send for lathe catalog.
W. F. & JOHN BARNES CO., 990 Ruby Street, Rockford, Ill.

ELEPHANT BRAND
DELTA
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THE PHOSPHOR BRONZE SMELTING CO., Limited.
2200 WASHINGTON AVENUE, PHILADELPHIA, PA.
ELEPHANT BRAND *Phosphor Bronze*
INGOTS, CASTINGS, WIRE, RODS, SHEETS, Etc.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS
ORIGINAL AND SOLE MAKERS IN THE U. S.

FREE
TO ANY ENGINEER
A Crosby, Tabor, American-Thompson or Lippincott
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Also 500 other things, including every article, tool or device any Engineer may want. For free premium list and full particulars regarding this remarkable offer, fill out and mail the coupon below to

FRANCE PACKING COMPANY, Inc.
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Manufacturers of METALLIC FIBROUS and SHEET PACKINGS

FRANCE PACKING CO., INC., Philadelphia, Pa.
Gentlemen:—Kindly send me premium list and full particulars regarding Indicators and other articles you are giving away.

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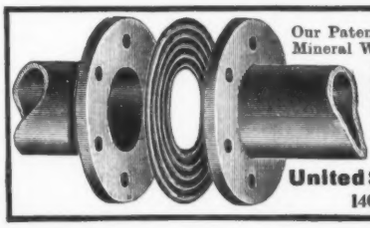
JOHNSON PACKINGS

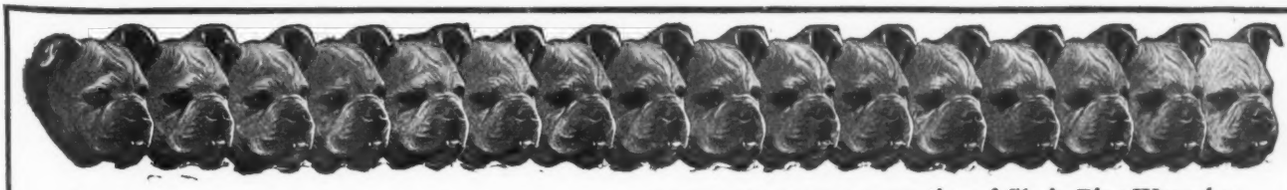
To the best possible design add generous quantities of honest material and the efforts of expert workmen, serve with a concrete guarantee—the result is Johnson's Packing. *Have a Catalog?*

THE HENRY JOHNSON COMPANY,
175-187 GATES AVENUE, JERSEY CITY, N. J.

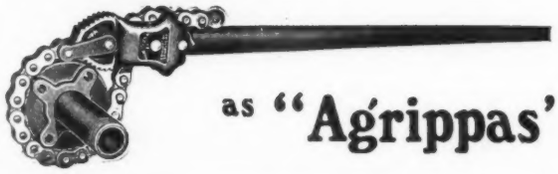


Our Patented Mineral Wool **Pipe Covering and Copper Gaskets** Save Steam and Make Absolutely Tight Joints. Best and Cheapest. Samples Free.

United States Mineral Wool Co.
140 Cedar Street, New York



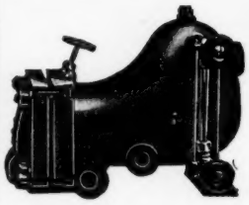
As insistent



as "Agrippas"

as we may seem on question of Chain Pipe Wrenches, we believe the course O. K. Every job has its kinks and irregular, close or cramped fittings, too cramped for other tools with two jaws. Agrippas have one jaw, all the strength and "get there" on any kind of work. Agrippas are practically two tools in one because of utility. Discount and free trial from your dealer.

J. H. WILLIAMS & CO., SUPERIOR DROP FORGINGS,
BROOKLYN AND CHICAGO.



McDANIEL STEAM TRAPS

are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

Watson Steam Pump Governor

should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

All our goods are made in our own factory and tested before shipping. We guarantee them to give perfect satisfaction. Established 1878.

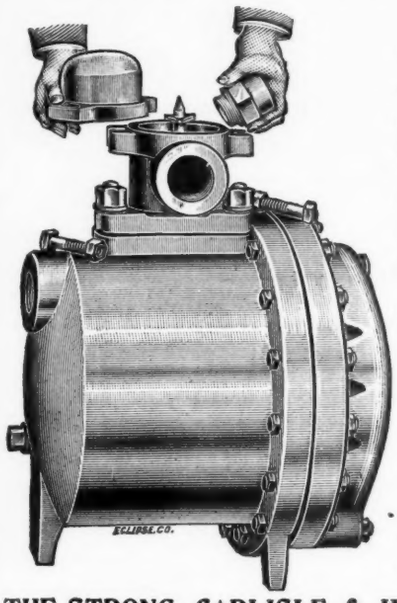
Send for Catalogue.

Watson & McDaniel Co.,
148 North 7th Street, Philadelphia, Pa.

OUR
STEAM TRAPS

4/S

have only two parts that ever need



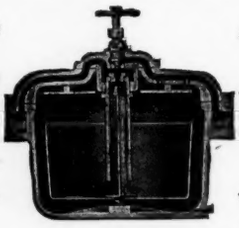
to be inspected —the cut shows how easy— TRAP is operated by an open cast iron BUCKET.

Send for our complete CATALOG "A" of STEAM SPECIALTIES

THE STRONG, CARLISLE & HAMMOND CO.,
342 Frankfort Ave., Cleveland, Ohio.
88 Broad St., Boston. 255 Centre St., New York. 54 No. 6th St., Philadelphia.

Nason Manufacturing Company's STEAM TRAPS

SPECIFY:
Class B for pressures less than 20 lbs.
Class C for pressures 20 to 70 lbs.
"Sidelug" for pressures 40 to 150 lbs.



THE TRAP THAT ALWAYS "FILLS THE BILL"

Nason Manufacturing Company's "Immersed Valve" Boiler Feeder

FOR LOW PRESSURE STEAM BOILERS

As a safeguard against the destruction of boilers through careless handling they are a necessary adjunct. Special Catalog.

NASON MANUFACTURING COMPANY
71 FULTON STREET, NEW YORK

The Internal Mechanism

Can be taken out for inspection or repairs by simply removing the cap—no need to break a single steam pipe or joint.

Get the "Trap Book"

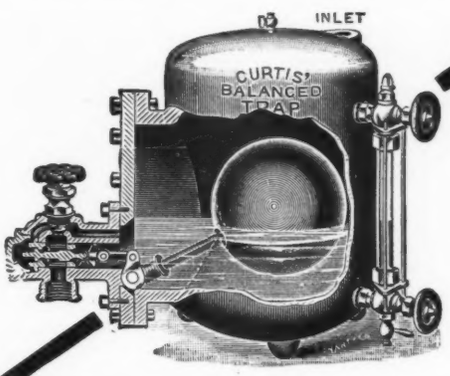
THE
V. D. Anderson Company
1935 W. 96th St., Cleveland, O.

Yes, We Do

send out GEIPEL STEAM TRAPS on approval. Shall we send you one?

Circulars on request.

JOHN PLATT & COMPANY,
99 Cedar St., New York.



That Engineer Is Getting Satisfaction

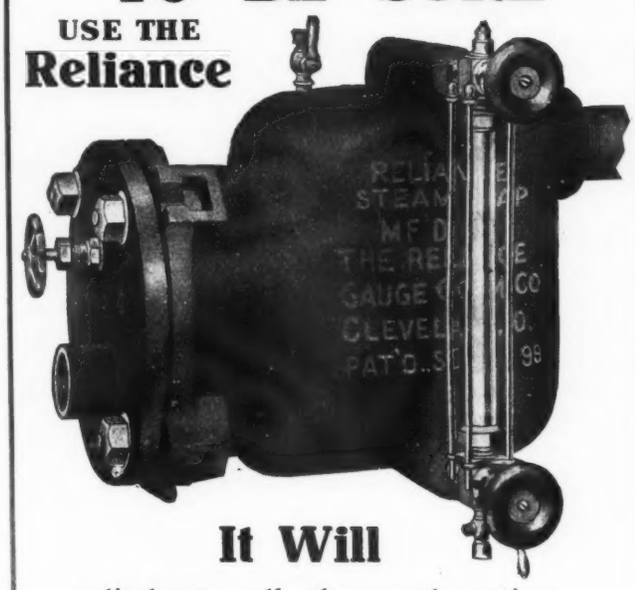
who has a CURTIS BALANCED TRAP working for him. Its sure, positive action and absolute accuracy make it invaluable wherever a trap is needed—absolutely reliable under all conditions, works under any pressure up to 250 pounds.

Do you know the CURTIS SPECIALTIES? Write for copy of latest catalog.

Julian d'Este Company
24 Canal St., Boston, Mass.

TO BE SURE

USE THE **Reliance**



It Will

discharge all the condensation, whether there is much or little, without loss of steam and without requiring attention, after it is once properly set.

Catalog?

The Reliance Gauge Column Co.,
75 E. Prospect St., Cleveland, O., U. S. A.

IT STANDS ALONE

SUPERIOR TO ALL

LASTS A LIFE TIME

"NOTHING SIMPLER"

Manufactured only by

The Ohio Blower Co.

Cleveland, Ohio, U. S. A.

STANDARD ENGINEERING COMPANY
TORONTO, ONT.

Exclusive Licensees and Manufacturers for the Dominion of Canada

1-10

OF WHAT USE ARE BAFFLE PLATES

in a separator anyway?

They don't arrest the water when it comes in a rush except to break it into fine particles that are the more easily carried off with the steam

Therefore the

STRATTON SEPARATOR

has none of them.

It throws the water out of the steam by centrifugal force and lets only the pure dry article pass to the engine.

The STRATTON always does the work when others fail.

Goubert Manufacturing Co.,
No. 90 West Street,
NEW YORK CITY, N. Y.

REILLY MULTICOIL

The Reilly Multicoil Feed Water Heater

High Efficiency on account of long travel of water through the coils; thorough agitation of water, therefore rapid absorption of heater; the scouring of the inside of tube walls caused by the centrifugal force of the flow **prevents scale accumulation** in the coils.

Every coil a spring, no temperature strains.

All tubes secured to headers with ground union joints.

Accessibility to interior parts through large door in the shell, without disconnecting pipes.

Tubes all standard and may be replaced by the engineer using no other tool than a wrench.

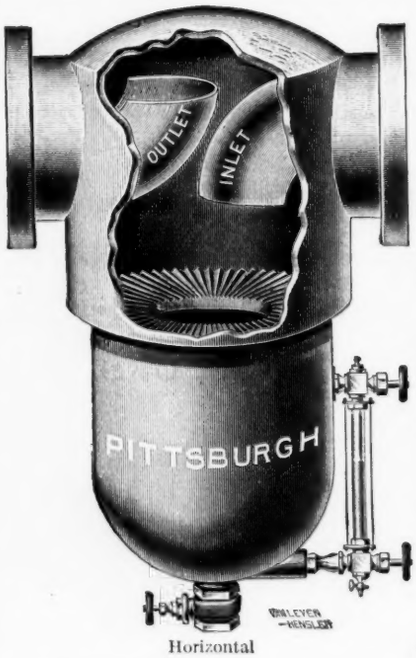
Sizes: 30 H. P. to 6000 H. P.

Write for Catalog.

THE GRISCOM SPENCER COMPANY
General Offices: 90 WEST ST., NEW YORK.

REILLY MULTICOIL

"Pittsburgh" Steam Separators



Horizontal

For Live or Exhaust Steam

Utterly Simple **Perfectly Effective**

Highest Efficiency—
Proved by Laboratory Tests.

No Baffle Plates—
To Cause Spattering Back.

No Contracted Areas—
To Retard Freedom of Flow.

No Small Passages—
To Foul and Clog.

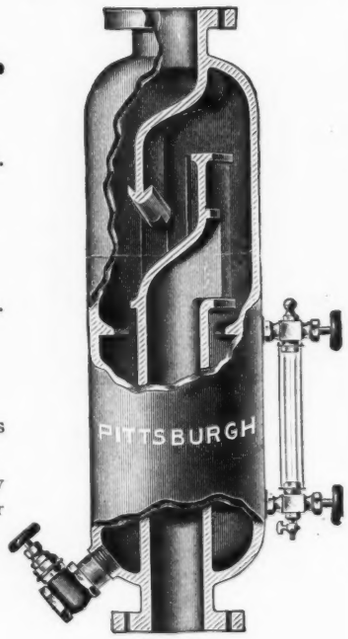
Perfect separation secured by sudden changes in direction of steam flow.

Separated water and oil drained directly away from steam current and into protected receiver space.

Horizontal and Vertical Types

Plain and Receiver Styles

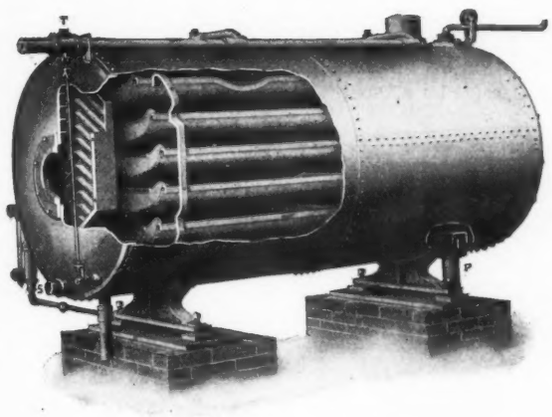
Made in all sizes—Shipped on Guarantee Trial.



Vertical

Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

HOPPES



Standard Steel Construction Heater.

STANDARD STEEL CONSTRUCTION

have shell and pans built of steel plate. Contain a large amount of heating and lime-catching surface and are especially recommended for bad waters containing large quantities of scale forming solids.

Every heater complete and ready for piping with oil extractor, water column, gauges and glass and automatic balanced regulating valve for controlling feed-water supply.

Write us stating capacity of your boiler plant and we will submit blueprint, specifications and price on a heater to meet your requirements.

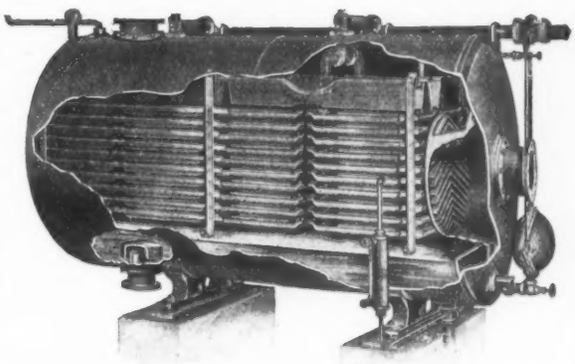
FEED-WATER

CAST IRON CONSTRUCTION

are built on the same principle as our Standard Steel Construction, but as all parts which come in contact with the water are of cast iron, they are peculiarly adapted to handling feed-water of an acid or corrosive nature.

CLASS "R" type has cast iron bottom and pans.

CLASS "H" type has cast iron pans and the cast iron bottom extends almost to center line of shell. This type is for use where a *large water storage capacity* is desired.



Cast Iron Construction Heater Class "R"

CLASS "T" type has all cast iron shell and pans and is built to meet requirements for an all cast iron heater.

HEATERS

We also manufacture LIVE STEAM FEED-WATER PURIFIERS, STEAM and OIL SEPARATORS and CAST IRON EXHAUST HEADS.

SEND FOR CATALOG

HOPPES MANUFACTURING CO.,

19 LARCH STREET, - - SPRINGFIELD, OHIO.

These samples from a well-known New England plant show how a

BLACKBURN-SMITH FEED-WATER FILTER AND GREASE EXTRACTOR

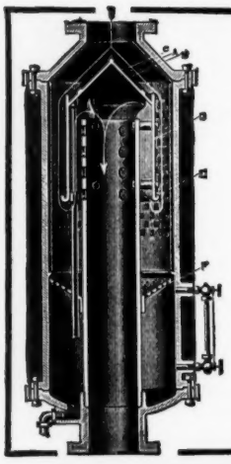
turns dirty water or condensed exhaust into good boiler feed.

The first sample contains traces of oil, rust, and other dirt from the heating system. The second, which is as clear as crystal, was taken after running the feed through our 2-in. filter at boiler pressure of 100 lbs. and temperature of 225° F.

It pays to save and filter the condensation. You don't have to buy as much water, you keep scale-forming matter out and you reduce repair and coal bills by putting into the boiler pure hot water which would otherwise go to waste. *Write for treatise, "Feed Water Filtration."*

JAMES BEGGS & CO., 106 Liberty St., New York

16



DON'T

buy a steam or oil separator without sending for catalog describing

SWEET'S

and then *read* and *think* about it and you'll order one: 6000 in use; deliver steam 99.8 dry; takes out all the oil, that is 99%.

DIRECT SEPARATOR COMPANY
712 South Geddes Street SYRACUSE, N. Y.

BAUM SEPARATORS

ARE BEST for Live and Exhaust Steam.

Positively Guaranteed.

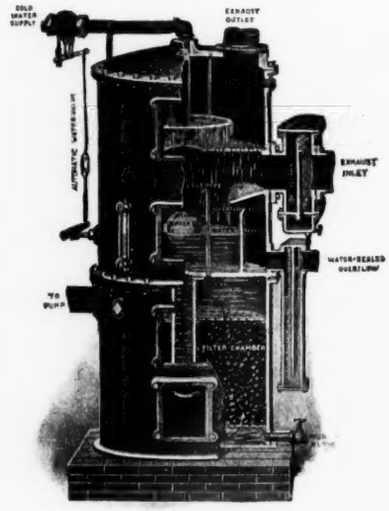
"I take pleasure in stating that this department has used the Baum Separators for a considerable time and has found them to be all you claim for them and are satisfactory in every respect."—The Superintendent of Public Buildings, Albany, N. Y.

Send for new Catalogue and prices.

Hershey Machine & Foundry Co.
85 Water Street, Boston, Mass. MANHEIM PA., U. S. A.

W. G. Ruggles Co., 54 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago, Ill.

THE WHITLOCK OPEN EXHAUST Feed Water Heater and Purifier

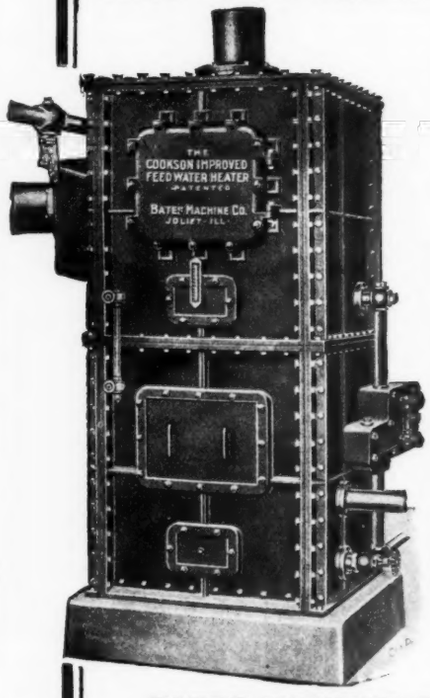


Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

Manufactured by

THE WHITLOCK COIL PIPE COMPANY
HARTFORD, CONN.
New York Office—Singer Building, 85 Liberty Street.

COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS



Highest Temperature and Positive Purification of feed water.

Perfect Separation and Removal of Oil.

Automatic Control of Cold Water Supply.

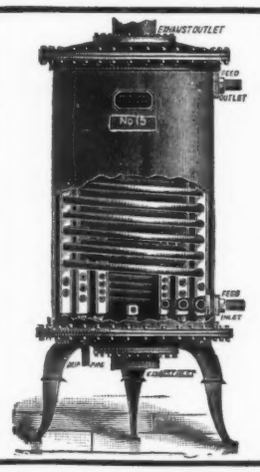
Dry Steam for Heating Purposes.

Finest Grade Special Fittings.

Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

Write for our new Heater Catalog.

BATES MACHINE COMPANY
Sole Manufacturers **Joliet, Illinois**



ECONOMY OF

PRICE, SPACE, COAL

The National Feed Water Heater is built on a simple, common sense plan which insures leakless joints, absence of back pressure, complete separation of water from the iron shell and withal remarkably high efficiency.

CATALOG?

THE NATIONAL PIPE BENDING COMPANY

175 LLOYD ST., NEW HAVEN, CONN.

120 Liberty Street, New York.
54 High Street, Boston, Mass.

Free Trial

at which you may be both judge and jury while we pay all the costs.

Patterson-Berryman Feed Water Heater

almost boils the feed water with exhaust steam that would otherwise be wasted. It extracts all scale forming impurities and protects your boiler against contraction and expansion troubles.

Write for details.

Frank L. Patterson & Co.

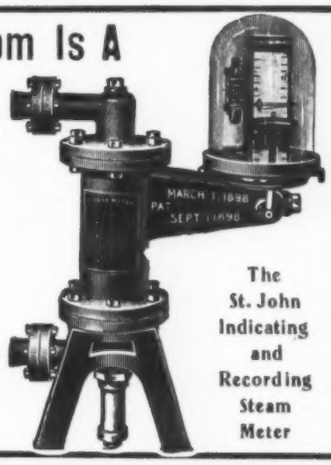
28 Cortlandt Street, New York, U.S.A.

Your Boiler Room Is A Steam Factory

and as such it's output should be accurately measured and a permanent record kept for reference and comparison.

WRITE.

G. C. ST. JOHN
140 Cedar Street
NEW YORK



The St. John Indicating and Recording Steam Meter

KITTS MANY MONEY MAKING SPECIALTIES

Pump Governors
Reducing Valves
Steam Traps
Safety Feed Water Regulators
Fan Engine Regulators
Low Water Alarms

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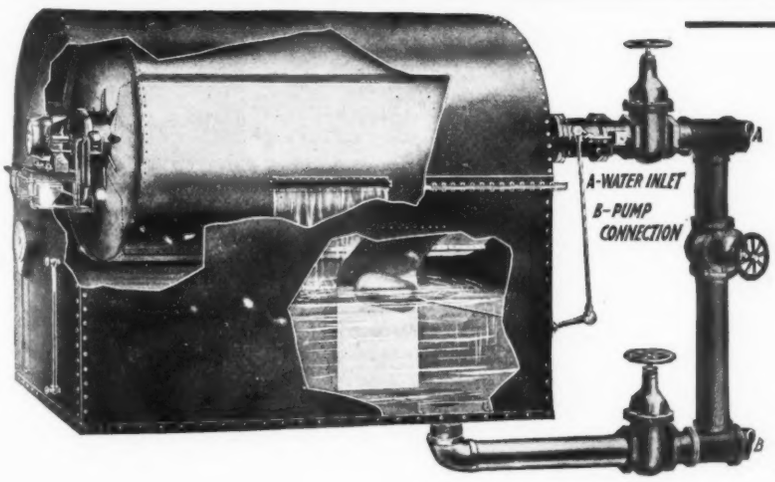
Safety Water Columns
Damper Regulators
Low Pressure Boiler Feeders
Vacuum Pressure Reducing Valves

KITTS MANUFACTURING CO., - OSWEGO, N. Y.



What Are Your Boilers Doing?

Are you getting the best economy?
Is your coal best fitted for your purpose?
Can You Tell Your Evaporation?
A

DETROIT METER

Will Give You a Continuous Record of Your Boiler Feed Water

Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

CENTRAL STATION STEAM COMPANY
Detroit, Mich., U. S. A.

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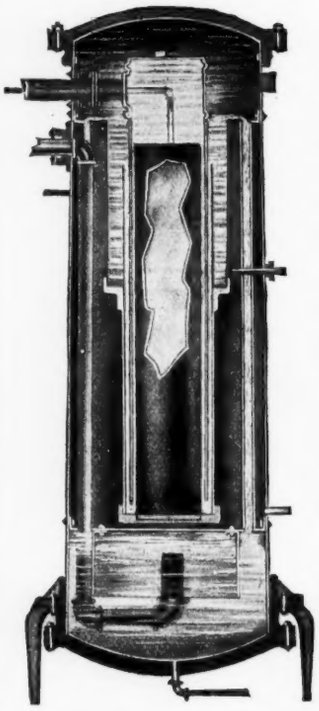
Your Largest Loss Is The Cost Of Scale



The Eclipse Feed Water Heater and Purifier eliminates the scale-forming impurities from the feed water before it reaches the boiler.

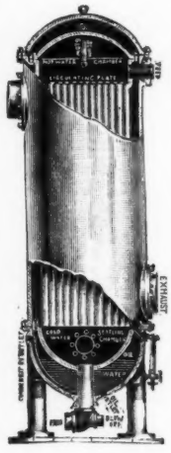
Scaleless boilers last three times as long and give much better service on a fraction of the fuel.

Ask for the book.

THE ECLIPSE FEED WATER HEATER AND PURIFIER CO.

Oshkosh, Wisconsin.

A COLD BATH Isn't Good For Your Boiler



Feeding it with cold water under mines its constitution, besides undermining your coal heap.

The Riblet Feed Water Heater uses the exhaust steam to heat the feed water, and gives your boiler a **hot bath** of 210° temperature. Makes the coal heap last longer. Easy to clean.

Write for Our Catalog?

ERIE MFG. & SUPPLY CO.,

1203 PEACH ST., ERIE, PENNA.

Doubly Efficient Because Doubly Heated

The Baragwanath Heater wears a steam heated overcoat which heats the outside of the shell and with which there can be

No Cooling Surface

The ordinary single shell heater naturally cannot raise water to 212° on so small a power consumption since it loses heat through radiation. *Write.*

WM. BARAGWANATH & SON,

54 WEST DIVISION ST.,

CHICAGO, ILLINOIS, U. S. A.

Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager.

Water, Scale And Oil

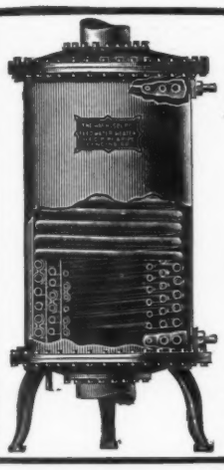
The Otis Feed Water Heater and Purifier heats the FIRST, eliminates the SECOND, and separates the THIRD.

It uses the exhaust steam only and operates without expense. We'll send it on trial. If it fails in any way to give entire satisfaction, send it back. We'll pay freight.

We *guarantee* **twelve** stipulated things. Shall we tell you what they are?

THE STEWART HEATER COMPANY,

45 E. Delavan Avenue, Buffalo, N. Y., U. S. A.



HARRISBURG FEED WATER HEATER

of Pure Seamless Copper Coils

Guaranteed to be the most effective, most durable and cheapest heater manufactured.

COPPER, IRON AND BRASS PIPE

Coils and Bends of any desired shape. Manufacturers of High Grade Wrought Iron Pipe, Black or Galvanized. Write for descriptive catalog.

Manufactured by

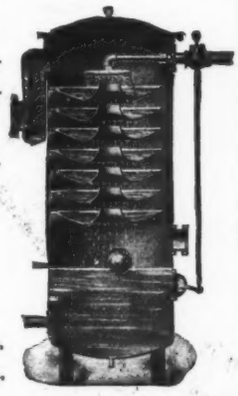
The Harrisburg Pipe & Pipe Bending Co.

950 Herr Street, HARRISBURG, PA.

The Wickes Heater

Exhaust steam utilized for heating water for boiler feed or laundry work.

Simple, effective, durable. Tested like a boiler.



The Wickes Boiler Co.

MAIN OFFICE AND WORKS:

Saginaw, Michigan

SALES OFFICES:

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1189 American Trust B'ld'g, Chicago, Ill.
Penobscot B'ld'g, Detroit, Mich. Empire B'ld'g, Pittsburg, Pa.
601 Brown-Marx B'ld'g, Birmingham, Ala.

KOERTING
Continuous Water Heater Condenser and Exhauster

This apparatus is intended for the direct application of steam to water heating, while flowing through pipe under pressure.

Also as a Condenser and Exhauster, for heating coils and on the exhaust pipes of engines.

It can be used with steam of any pressure or with exhaust steam, or for the maintenance of a partial vacuum with steam below atmospheric pressure, or as an Exhauster for the removal of air only.

The capacity and range in volume is regulated by the central hand wheel, and when used for heating water its temperature is regulated by throttling with a valve in the steam pipe.

WRITE FOR CATALOG 3-A

SCHUTTE & KOERTING CO.

Tompson and 12th Sts., Philadelphia

New York: 50 Church Street
Boston: 43 High Street
Pittsburgh: Keenan Building
Chicago: 805 Security Bldg.

Your Engine May be Cheating You—

Install a

Robertson-Thompson Indicator
And Victor Reducing Wheel

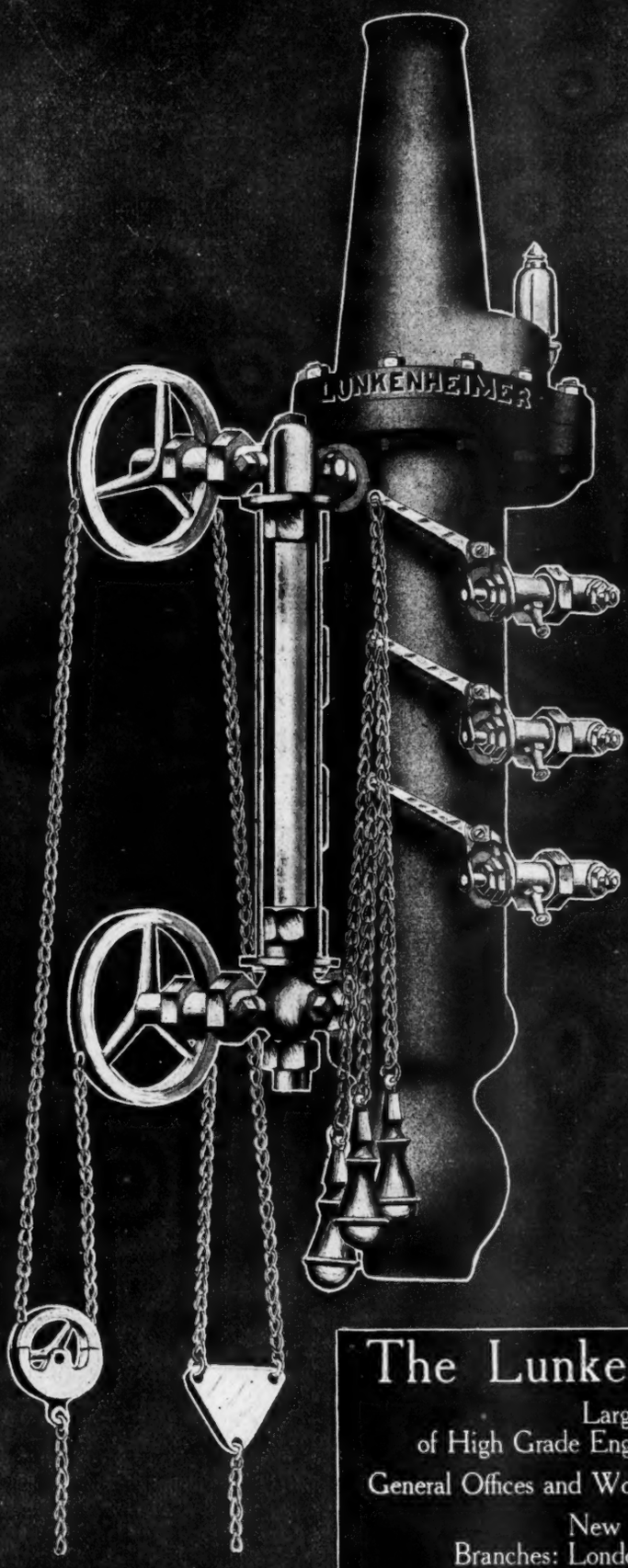
and you will get perfectly accurate records of just how much power the engine is developing for the fuel consumed. You will also get knowledge not to be had in any other way. Any engineer can buy this outfit and hardly feel it, because of the moderate price and our easy terms of payment.

The Willis Planimeter is the most perfect instrument on the market and price very moderate.

Write us for Catalog and details of our offer to engineers.

Jas. L. Robertson & Sons,

46 Warren Street, New York.



No Engineer can have a more FAITHFUL assistant than the

Lunkenheimer "Vigilant" Safety Water Column

It automatically sounds an alarm when the water in the boiler approaches the low or high danger limit, besides effecting a decided saving in fuel and boiler repair bills. Made in all sizes suitable for various types of boilers. Our catalog contains a complete description. Write for a copy.

The Lunkenheimer Company

Largest Manufacturers
of High Grade Engineering Specialties in the World

General Offices and Works, Cincinnati, Ohio, U.S.A.

New York, 66-68 Fulton St.
Branches: London, S. E. 35 Great Dover St.
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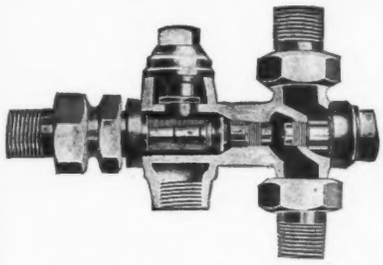
6

The Desmond Automatic Injector
The Acme Of Simplicity



As far superior to the old style complicated Injectors as modern machinery is to that of a Generation ago.

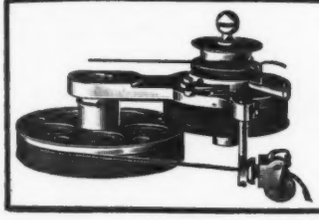
Every one fully guaranteed. Accept no out-of-date substitute. Insist upon the DESMOND. Write for Catalog.

The Desmond-Stephan Mfg. Company,
Urbana, Ohio.

THE MASON REDUCING VALVE

Catalog?

THE MASON REGULATOR CO., Boston, Mass.



Guaranteed

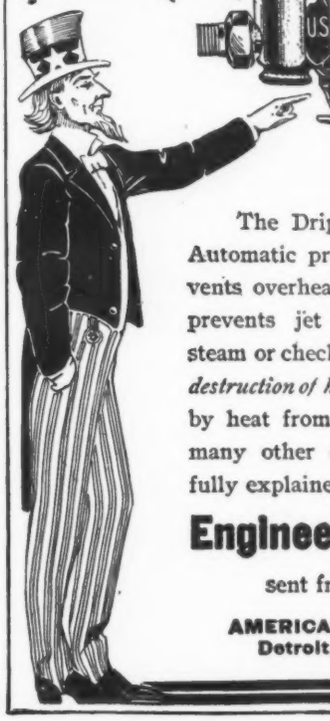
to work at higher speed than any other. Trill's Faultless Reducing Wheel. *Catalog?*

TRILL INDICATOR CO.,
Eagle St., **Corry, Pa.**

No Freezing Here

The Drip Cock prevents it

U.S. Automatic Injector



The Drip Cock of the U. S. Automatic prevents freezing; prevents overheating of suction pipe; prevents jet "liming up" when steam or check valve leaks; *prevents destruction of hose on traction engines* by heat from hot water, and has many other exclusive advantages fully explained in our

Engineer's Red Book

sent free on request.

AMERICAN INJECTOR CO.
Detroit, Mich., U. S. A.

Chicago Automatic Injector

Chicago Automatic Injectors
Prove their Quality in Actual Operation

No boiler feeding troubles when you have a powerful Injector that is built for service.

The Chicago Guarantees a Full Boiler when you want it

It is positive in its work and has nothing to get out of order. Built unusually strong.

THE BEST PROTECTION FOR BOTH BOILER AND ENGINEER

You cannot afford to be without it. It makes the power plant complete.

THE CHICAGO EJECTOR, a powerful little instrument for elevating, forcing and conveying liquids. Does marvelous work with but little steam.

Write for description and catalog of both the Chicago Injector and Ejector.

Chicago Ejector

THE OHIO INJECTOR COMPANY,
The World's Greatest Injector Manufacturers.
WADSWORTH **110 Main Street** **OHIO, U.S.A.**

DAVIS PRESSURE REGULATORS SAVE STEAM

PRESSURE REGULATOR

Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

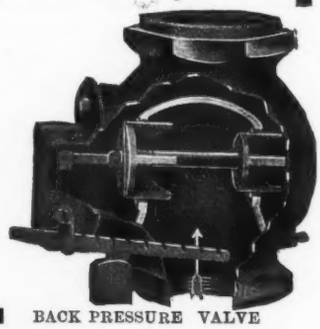
If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.

G. M. Davis Regulator Company,
142 Milwaukee Ave., CHICAGO.

BRANCHES—NEW YORK—123 Liberty St. BOSTON—104 High St. ST. LOUIS, 735 S. 4th St.
SAN FRANCISCO—216 California St. PHILADELPHIA—56 N. 2nd St.
PITTSBURGH—1206 Park Building.



BACK PRESSURE VALVE

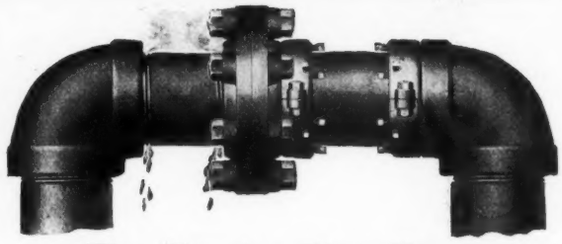
VALVES

Makes no difference what kind of a Valve you want, how you want it made or where you want it shipped, we can supply it on shortest possible notice.

We manufacture Valves, and Pipage Equipment of every description, for all kinds of plants, Steam Separators, Tuyere Cocks, Brass Unions, etc. Also make Pipe Bends, and do all kinds of Pipe Fitting, either assembled or ERECTED.

Send for catalog.

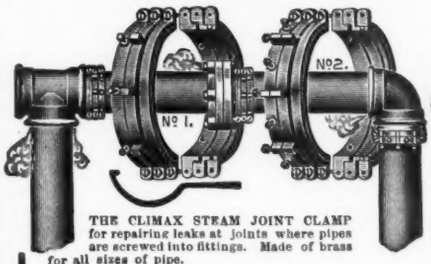
PITTSBURGH VALVE FOUNDRY & CONSTRUCTION CO.,
Pittsburgh. Cleveland. New York. Boston.
Birmingham, Ala.



The Simplex Pipe Clamp

absolutely guaranteed to make the worst leaky joint permanently tight—sent on 30 days' free trial.

THE SIMPLEX ENGINEERING CO.,
316 Preston Street, PHILADELPHIA, PA.



THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.

THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION
Send for Catalog of
STEAM SPECIALTIES
JAMES McCREA & CO.,
MANUFACTURERS,
61 West Washington Street, Chicago.

NELSON VALVES

FOR SUPERHEATED STEAM

Every line in the design—
Every ounce of metal—
Every touch in the manufacture—

of the Nelson Steel Gate Valve for Superheated Steam is the result of patient, careful and thorough study of its exacting requirements.

The design is absolutely new, and embodies every feature necessary to make the valve indestructible, fool-proof and tight.

The body and bonnet are of a special grade open-hearth steel of 65000 pounds tensile strength; and the trimmings—including the stem and all working parts—are of almost pure nickel, a composition perfectly non-corrosive and exceeding the open-hearth steel parts in strength.

The cork-handled hand-wheel facilitates ease and comfort of operation; the special swing-bolted stuffing box is protected from the extreme heat by elongated condensing chambers, so that they can be comfortably packed when open.

They are guaranteed—absolutely and expressly—to successfully withstand the extraordinarily destructive action of steam at high pressures and temperatures.

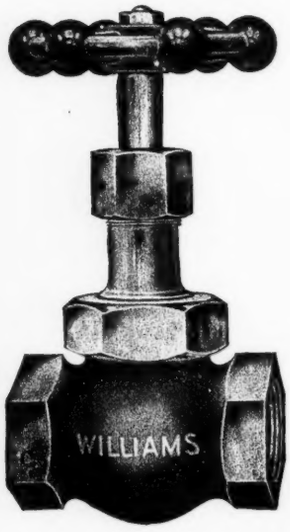
Full details on application.

Nelson Valves are made in the Gate, Globe, Angle and Check types, in all sizes, of Iron, Bronze or Steel, for all pressures, for any service.

THE NELSON VALVE COMPANY
PHILADELPHIA, PA.

NEW YORK	HUDSON TERMINAL BLDG.
CHICAGO	40 DEARBORN STREET
PITTSBURGH	525 THIRD AVENUE
MINNEAPOLIS	622 ANDRUS BLDG.
SAN FRANCISCO	ATLAS BUILDING

"Ask The Man Who Uses Them"



and he will tell you that "valve troubles" are a thing of the past. No leaks, no repair bills, work or worry since he started to use

WILLIAMS VALVES

because a "Williams" Valve is heavily constructed, and begins its longest term of usefulness after all other valves are out of service. It can be reground time and again at no extra cost. The operation requires but a few minutes without disturbing the pipe, and when finished the valve is as good as when new.

Strictly speaking, it is the only valve you can repack under full pressure of steam without burning your fingers.

Let your next order read—WILLIAMS.

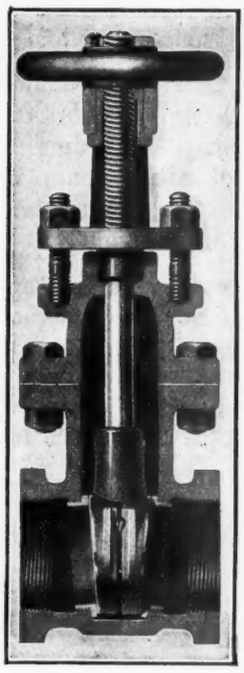
The Williams Blue Book should be in the hands of every wide-awake power user. It's worth having. It contains nearly 200 pages, with 500 handsome illustrations showing our complete line, and is full of valuable tables, data and useful engine room recipes. Just off the press. New, fresh and interesting. We want you to have a copy. A postal with your full address brings it in the next mail. Don't delay. Write today.

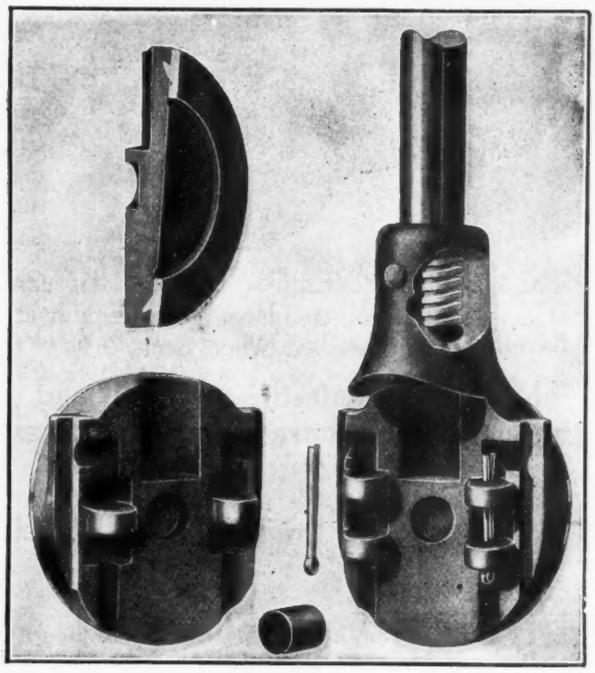
The D. T. Williams Valve Company,

CINCINNATI, OHIO, U. S. A.

IF YOU ARE INTERESTED IN POWER PLANT EQUIPMENT YOU WILL BE INTERESTED IN THE

PITTSBURGH IRON-BODY GATE VALVE



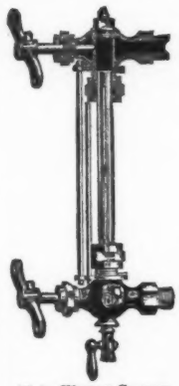


for the following reasons:

1. This valve combines the features of both the solid wedge and loose disc valves and does not have the disadvantages of either. This is done by making one of the discs a solid wedge and hinging the other to it as shown in sketch so as to allow both to adjust themselves to the seats.
2. This valve has less wear on the faces of the discs and seats than any other valve made. This is secured by having the discs guided by ribs cast in the body of the valve thus allowing them to lift away from the seats without scraping and abrading.
3. This valve will not leak due to expansion strains from piping because the bosses are drilled and pinned together with cotter pins so loosely that they can move in either direction upon the plug and adapt themselves to the seats whatever the conditions may be as to parallelism.
4. The discs of this valve are faced with steam metal which is forced into an undercut groove in the face of the disc by a special machine using rolling pressure, which both compacts and surfaces the metal.
5. Quality is never sacrificed to secure cheap production. This valve is made of the highest grade material and is finished by skilled mechanics with the latest and most approved machinery that money can buy.
6. Thousands of these valves are in use in all parts of the country and we have never had a complaint.

PITTSBURGH VALVE & FITTINGS CO., General Offices and Works, BARBERTON, O.

Pittsburgh Gate Valves are made Standard for 150 lbs. and Extra Heavy for 250 lbs. working pressures. They can be furnished Flanged, Screwed or Hub End, with Non-Rising Spindles or Outside Screw and Yoke. Write for Catalogue.



Ohio Water Gauge

"OHIO" STEAM SPECIALTIES

ACCURATE WORKMANSHIP, CORRECT DESIGNS AND HIGH GRADE STEAM BRONZE ARE ALWAYS TO BE FOUND IN OUR STEAM SPECIALTIES. THEY ARE MADE FOR THE ENGINEER WHO WANTS HIS POWER PLANT EQUIPMENT TO BE THE *BEST OBTAINABLE* IN BOTH FINISH AND OPERATION.

CATALOG P-F TELLS ALL ABOUT "OHIO" STEAM SPECIALTIES.

CATALOG P-B TELLS ALL ABOUT OUR COLLIN STEAM PRESSURE REGULATOR

THE OHIO BRASS CO., MANSFIELD, OHIO

NEW YORK, 32 Cortlandt St. ST. LOUIS, 10 North 4th St.
CHICAGO, 277 Dearborn St. SAN FRANCISCO, 138 Front St.

Ohio Gate Valve

Erwood Swing Gate Valves

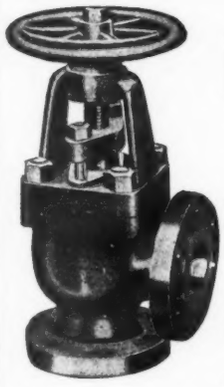
Manganesite Paste for Joints

WALCH & WYETH, 87 Lake St., Chicago.

VALVES THAT LAST

invariably prove to be HOMESTEAD VALVES. Their quality is unequaled. They are simple, quick acting and operate on a Quarter-Turn. Get the BEST—it pays! Booklet?

HOMESTEAD VALVE MFG. CO.,
PITTSBURG, PA., U. S. A.



Manufacturers of the

EDWARD VALVE

For High Pressures,
Superheated Steam and Water.

THE LAMMERT & MANN

Oil Dash Pots for Corliss Engines,
Gas and Gasoline Engines.

LAMMERT & MANN,

ENGINEERS and MACHINISTS,
157 S. Jefferson St. CHICAGO, ILL.

Know The Pressure With Its Variations Both Day And Night

The Ashton Pressure Recording Gage keeps an exact and official record of all pressure variations for Steam, Water, Air or Gas, with the *time* and *duration* of all changes.

Steam Boiler Plants will find these gages particularly valuable for keeping up a uniform steaming efficiency and for preventing careless firing. Any omission of duty is recorded. Write for complete catalog.

The Ashton Valve Company,

Boston New York Chicago
St. John's House, London, E. C.

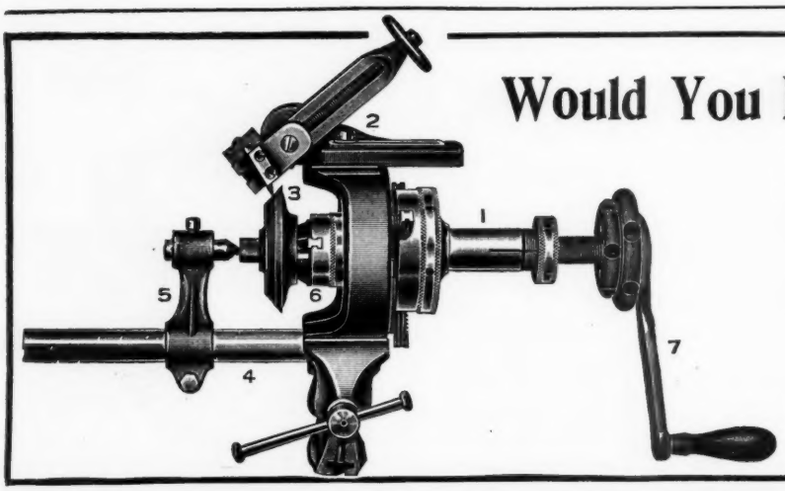
EVERLASTING BLOW-OFF VALVE

Straight-through flow. No stuffing-box. Easily operated. Self-cleaning; self-grinding seats. Easily repaired. Send for descriptive booklet and prices.

SCULLY STEEL & IRON CO.,

CHICAGO

J. B. HACKETT, 5 TEMPLE COURT, NEW YORK REPRESENTATIVE.



Would You Hesitate One Minute

ordering a Morse & Dexter Valve Reseating Machine if you were positive it would keep your valves perfectly tight, and the machine would save enough to pay at least half its cost before the bill became due?

You can have a machine 30 days, use it all you care to and then return it at our expense if you do not want it.

Send for Catalog P. illustrating these machines.

THE LEAVITT MACHINE CO.,
ORANGE, MASS., U. S. A.

Hinged Pipe Vises

Made in 4 Sizes

Ranging from 0 to 6 inches

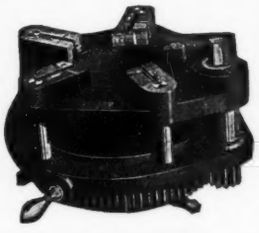
Catalog on Request

Manufactured by

The Armstrong Mfg. Co.
Bridgeport, Conn.

287 Knowlton, St.

This Mark Means the Genuine



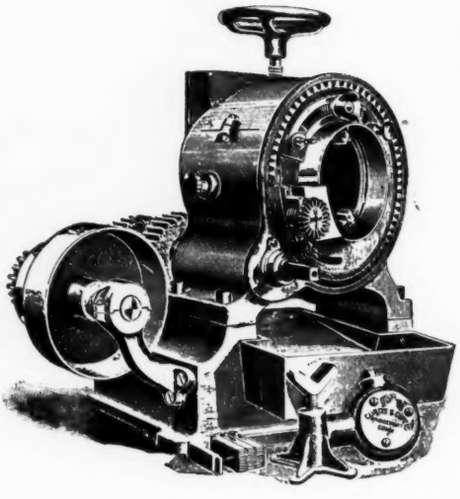
EMERGENCY WORK IN POWER PLANTS MUST BE DONE IN A HURRY.

"TOLEDO" Pipe Threading Devices

thread pipe up to 12". ONE MAN can do it quickly and *in any place, in any position.* An invaluable line of tools. Let us tell you about them.

The Toledo Pipe Threading Machine Co.,
TOLEDO, OHIO.

The Only Machine



on which the shell adjustment compensates for the wear of the gears is

Forbes Patent Die Stock.

It is also the only machine on which one man can cut and thread pipe up to 15-in. It cuts true, straight, uniform threads and can be operated in cramped quarters. CATALOG?

The Curtis & Curtis Co.,

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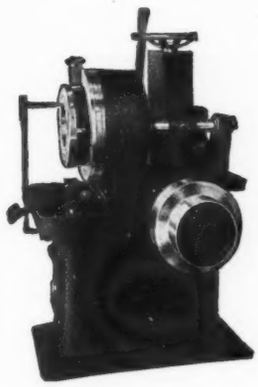
The Singer Building Uses LOEW VICTOR PIPE MACHINES Model 1908

THE BEST PIPE MACHINE

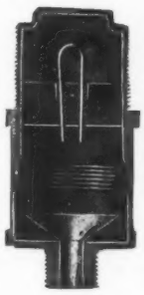
is found in the machine shop of the tallest and most modern building in the world.

High Priced lathe-bed outfits cost twice as much as the "Loew Victor" and yet do no better work. We invite comparison with any other make. Catalog?



The LOEW MANUFACTURING CO.,
CLEVELAND, O.

The "Philadelphia" Grease Cup



Automatic application of grease to the bearing without the use of spring compression. : : : :

Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : :

With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

Write for catalogue and full information

The Philadelphia Lubricator & Manufacturing Co.
The Bourse (Exhibition Dept.), Philadelphia, Pa.

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BEAVER

It's Ready for Use on Any Size Pipe—Without Changing Dies. One Man Cuts ANY Size

No 6—Cuts ¼ to ¾" without changing dies or bushings.

BEAVER DIE STOCKS ARE MADE IN ALL SIZES. Each size cuts the four sizes within its range without changing dies, adjustable, and capable of cutting nipples and crooked threads.

CONSIDER THE CONVENIENCE AND ECONOMY of Die Stocks which save the time of changing dies, no loose parts to get lost or misplaced—and one man can cut ANY size thread.

SOLD ON 10 DAYS' TRIAL BY ALL JOBBERS.

WRITE US TODAY FOR PARTICULARS.

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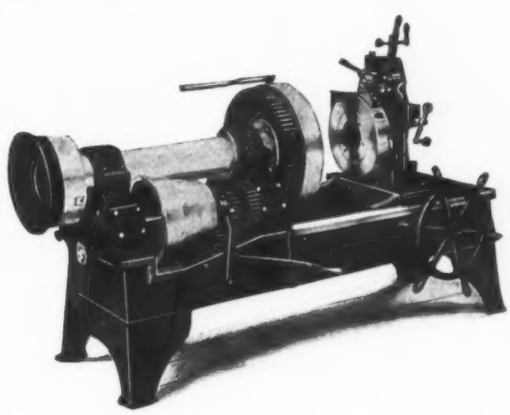
DEPT. F.



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LATEST IMPROVED

ROCHESTER

AUTOMATIC LUBRICATORS

give perfect force feed lubrication and *save oil, time, money* and *labor.*
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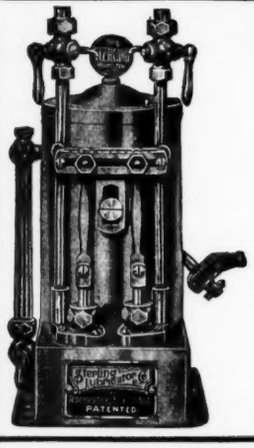

The Time, The Place, And The Oil

in just the proper amount are looked after by the Sterling Force Feed Lubricator. The machine is supplied as it needs lubrication and not a drop of oil goes to waste. Ask for Catalog.

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Excellent. Economical.
G. W. Hoffman, Sole Prop., 295 E. Wash. St., Indianapolis, Ind.
INFALLIBLE
FOR POLISHING GOLD, SILVER, PLATED WARE, NICKEL, TIN, BRASS, COPPER, Etc.
DIRECTIONS:
Take a little of the Polish on a soft cloth, rub the Metal hard and then wipe it off with a dry cloth.
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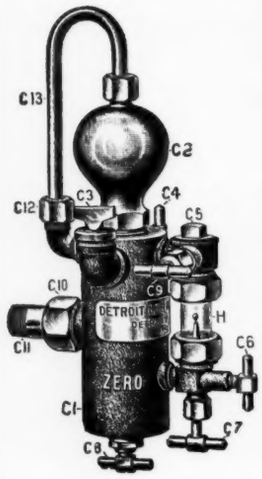

Lubricator for 20 days. We'll send you one on trial so that you can *see it work.* If you don't like it don't pay for it.

Detroit Lubricators will give lasting satisfaction. They're built to *work* under all conditions. Over 950,000 in daily active use.

This Detroit "Zero" operates exposed engines or pumps in zero weather. Prepare *now* for the future. Cata'og?

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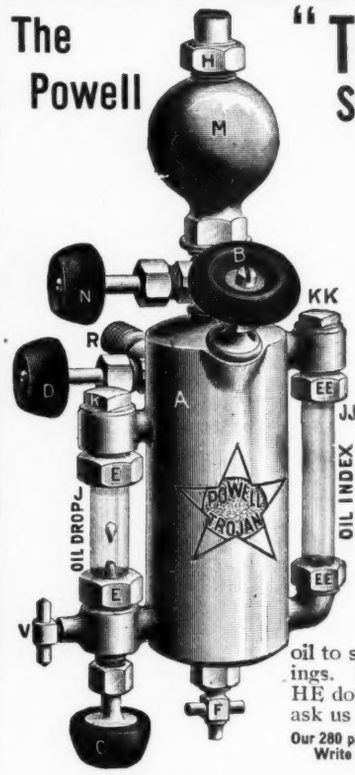
DETROIT, U. S. A.

The Powell "TROJAN" Sight-up-feed Cylinder Lubricator



A thoroughly efficient double connection lubricator of neat design, superior workmanship and finish.
The body-shell is cast in one piece—a patented Powell construction. This insures positive feed and perfect lubrication under all conditions, as the arms can't get out of line and there are no joints to loosen or leak.
Oil chamber is filled direct through filling cap B on all sides. You don't have to wait for oil to seep through small openings. See it at your jobbers, if HE does not carry it in stock, ask us who does.

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No **one** kind is good for **all** belts—
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We use only A-1 heavy packer steer hides, which tanned by our special process, make belts with soft kid-like surface, and strong, tough pliable interior.
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SABLE remains flexible without being "doped," gives from ¼ to ⅓ more pulling power than any oak-tanned belting and is especially fitted for quarter turn or cross drives or small pulleys.

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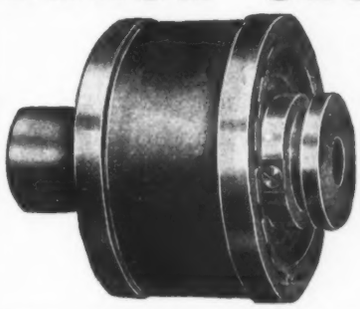


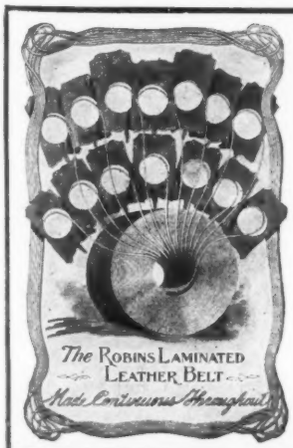
Hundreds who tried out other clutches that failed to make good, found just what they wanted when they installed the Akron.

It saves power, expensive shut downs and accidents to employes. Works perfectly at high speeds and starts the load gradually and quietly.

Try the Akron and you won't have to experiment with others.

Write to

The Williams Foundry & Machine Co.,
Successors to the Akron Clutch Co. **Akron, Ohio.**



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Eliminates The Glue Pot

SOLVES THE BELT PROBLEM.

The Scientific Principle:
Continuous strands are spirally cut from the choicest leather locations of the belting butt to exact mechanical gauge. The strands are then separately stretched to the extreme elastic limit and assembled on edge forming a belt of any practical length, width or thickness. Made endless on pulleys with a simple interlocking splice.

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A continuous belt without laps, plies or cement. Absolute uniformity of strength, gauge, balance and flexibility. Complete adjustment to varying pulley conditions with the maximum of surface and circumferential contact. Remarkable power transmission and highest productive efficiency.

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will make any belt pliable and tough.

It drives out the old sticky dope that never can do any good, and restores to leather the natural strength and vitality lost in tanning.

OXOILOX is a leather food and preservative, not a drug.

All it does is to keep leather soft and strong and tough, so that it clings closely to the pulleys. But that is the whole theory of correct belt practice. Belts should cling so closely to pulleys that air is excluded from between the two surfaces. The partial vacuum thus formed makes slipping almost impossible and enables belts to do their full duty running slack.

OXOILOX is Nature's remedy for slipping belts.

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Gentlemen:—Kindly send me, free of charge, a Sample Can of OXOILOX, the perfect belt dressing.

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Recommends it for all heavy transmission and conveyor work

(The belt with the undesirable features eliminated)

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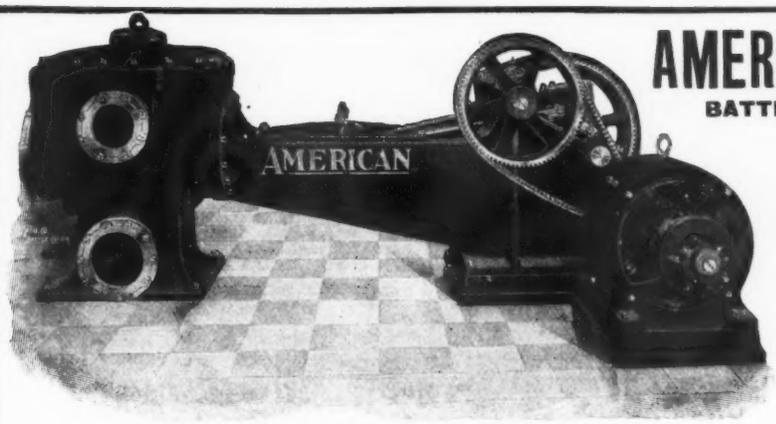

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We make a specialty of VACUUM PUMPS, both STEAM and POWER, for heating systems.

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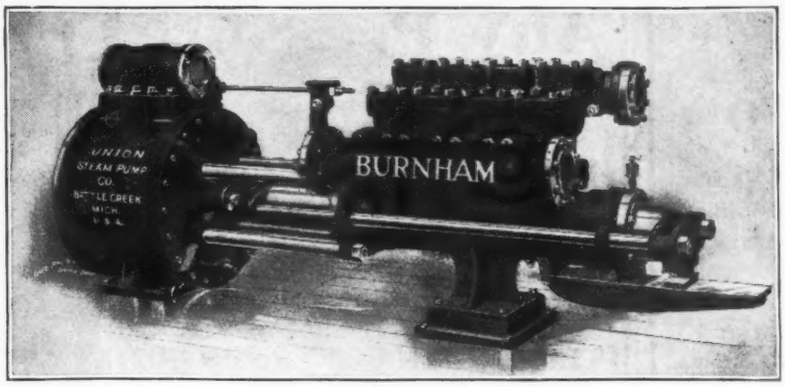
To be simple is to be great.



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Steam, belt and moto -driven
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In use under Stationary Boilers,
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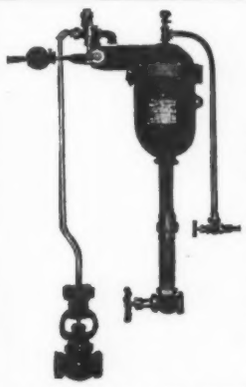

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Costs Less to Operate and Maintain

Constructed on a different and better principle than any other.
Investigate it and the

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A guarantee from a responsible firm with every machine.

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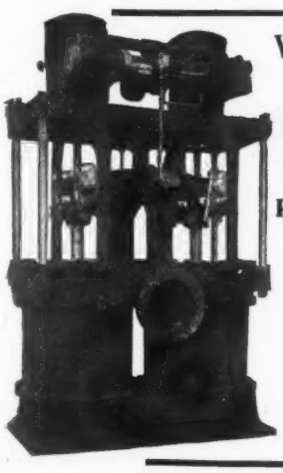

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Piston–Plunger–Hydraulic
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Air Pumps and Jet Condensers Combined.

Air and Circulating, and Marine

Duplex Vertical Air Pump and
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Safety
Automatic
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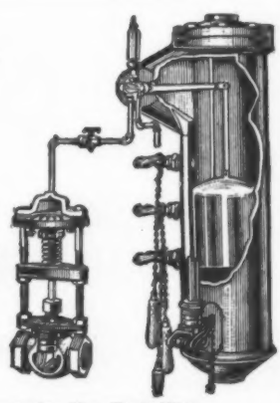
REGULATOR



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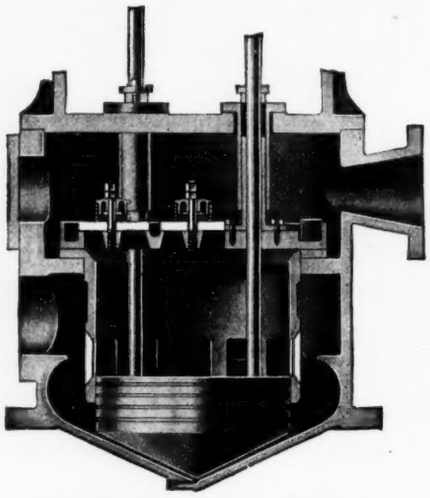

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Any Pressure

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here, is one of the condensers which are today condensing steam from several thousand engines in power houses of all kinds. If thinking of installing a condensing apparatus, why not specify a Deane Condenser. Our installations give results and not trouble.

Vertical Fly-Wheel Condensers.

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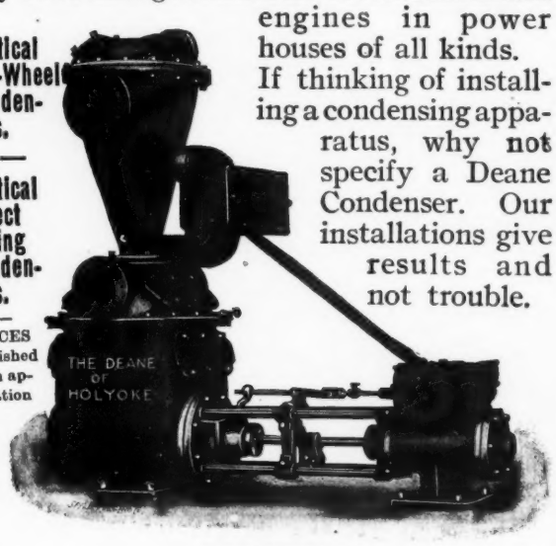

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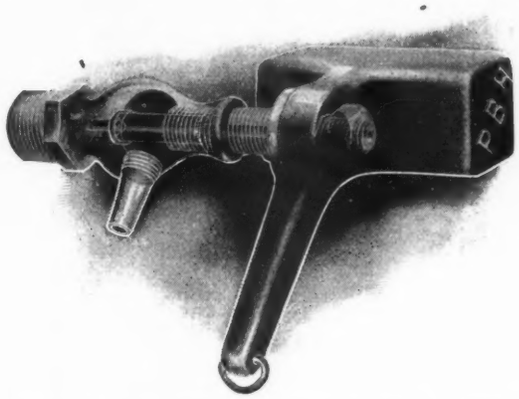

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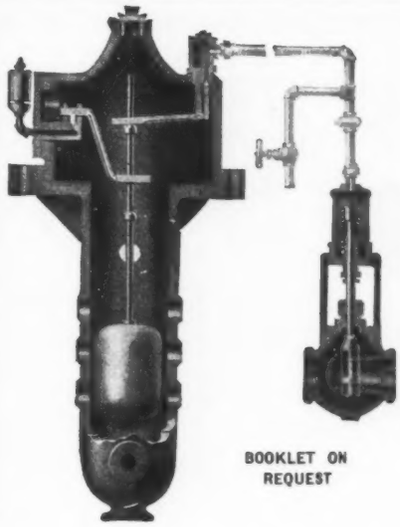

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is simple, positive and it fills every requirement perfectly. It furnishes a continuous feed in exact proportion to evaporation, thus holding the water to an absolutely unvarying level. Greater safety, greater boiler efficiency and greater economy must result. Booklet ?

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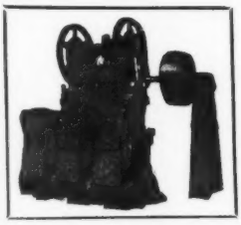

For any service. **Power**

For operation by any power. **Pumps**

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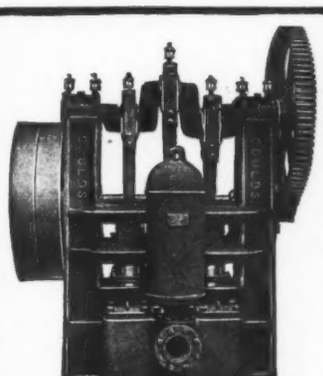

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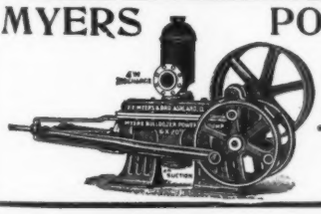

Adapted especially for gas engines, motor and belt powers, in harmony with present requirements.
Catalog sent on request.

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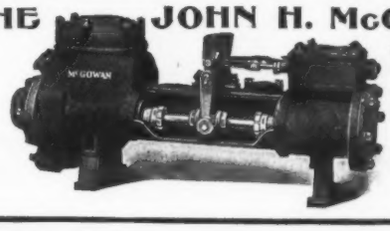
Ashland, Ohio, U. S. A.

THE JOHN H. McGOWAN CO.

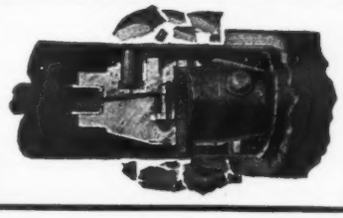


Cincinnati, Ohio

Builders of
PUMPING MACHINERY
Single Duplex and Fly-Wheel Types
Water Works Pumping Engines

THE "TORPEDO"

Removes all scale from tubes of fire tube boilers.
Saves 11 per cent. of fuel for each 1-16 inch of scale.
Prolongs life of tubes.
Saves compound.
Centers itself in tube.
Strikes same in every direction.
Stroke limited and cushioned.
Does not hammer but vibrates the tube.
Is absolutely safe and easily operated.
Has but one moving part.
Will last a lifetime.



The "Torpedo"

THE IDEAL CLEANER FOR FIRE TUBE BOILERS.

We invite every plant using fire tube boilers to send for a "TORPEDO" on free trial. If it isn't the best cleaner you ever saw, don't buy it. Every engineer should have a copy of our free circular No. 30. "How to Tell a Good Fire Tube Cleaner." For water tubes, send for circular No. 54 on straight tube, or No. 56 on curved tube "DEMON."

THE GENERAL SPECIALTY CO., 857 Niagara St., **Buffalo, N. Y.**

CLEAN WATER, CLEAN OIL, CLEAN TUBES and CLEAN PROFITS

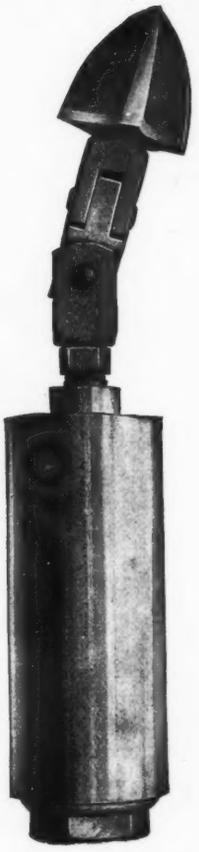
The Liberty Twin Strainer will deliver all the water and hold all the foreign matter, when necessary to clean it one side continues to strain while the other side is being cleaned.

The Liberty Oil Purifier makes it possible to re-use oil an almost indefinite number of times and each time the lubricant is as pure and clear as new oil.

Liberty Turbine Cleaners remove either heavy or light scale; remove all there is and that without damage to the tubes. Besides being easy to operate they require but half the time ordinarily taken to clean the boiler.

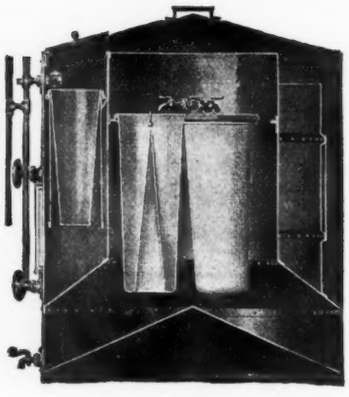
LIBERTY MANUFACTURING COMPANY

6509 SUSQUEHANNA ST., PITTSBURG, PA.



TURBINE CLEANERS

TWIN STRAINER



OIL PURIFIER

THE WEINLAND MECHANICAL CLEANER

DRIVEN BY AIR OR STEAM

POWER
SIMPLICITY
CONVENIENCE

SPEED
SAFETY
DURABILITY

TRY THIS WEINLAND CLEANER IN A COMPETITIVE TEST WITH ANY OTHER MAKE.

That is what Mr. C. W. Young, Manager of Exchange Ice Works, Montgomery, Ala., did and here is the result:

"I sometime ago tested your air machine against the ..... machine (air driven) and found that your machine would clean the tubes on an average of about seven minutes, cleaning our B. & W. Boilers in a short time. The representative of the ..... machine worked on one tube three hours and then did not get same clean, or even get his machine through the tube. The pressure used was from 80 to 100 pounds. I AM GLAD TO SAY THAT THE LAGONDA MACHINE IS ALL THEY CLAIM."

We will further back up Mr. Young's statements by putting one of these machines in your plant, and if it doesn't do better than cut your boiler cleaning bill in half, you can send it back.

Tell us how much and what kind of scale troubles you. We make many types and sizes of Weinland Cleaners, and if one of these cannot do the work, there is no cleaner made that can.

Don't forget our Turbine Cleaners. Many prefer this type. Our WING ARM HEAD makes it invincible. Used on all new cleaners. Can also be used on all those now in use.

Write for treatise "Boiler Scale and Its Removal."

THE LAGONDA MFG. CO., Springfield, Ohio.

Makers of Lagonda Automatic Cut-Off Valves, Reseating Machines and Tube Cutters.

New York Philadelphia Pittsburg Chicago San Francisco Birmingham Toledo

REGARDIN' DIRTY BOILERS

I've had my troubles with dirty boilers too, and many a time I have had that "take to drink" feelin', when I saw water squirt out on the tube ends. That's the way scale and grease generally show up, you know, after it's got in its work. Well, I used to wear over-alls three Sundays out of the month until I started to use

BIRD-ARCHER BOILER COMPOUNDS

and then I didn't wear 'em Sundays in three years.

It's all right to talk about them cleaners of the really and truly kind that sure get the scale out, but say, they don't make your back feel better when you have got to get inside the boiler and get tubes out, and you've never heard the boss say 'Hallelujah' when you told him you had to have 'steen new tubes for ones that had burnt out, and 'steen parts for the cleaner had to be bought new.

No, sir, the right way is to use BIRD-ARCHER COMPOUND, because it's easy to handle and guaranteed to do the trick. If it doesn't cut out the scale and grease and stop pitting and grooving, you don't have to pay for it.

Better ask for their Book *"Ten Questions for Steam Boiler Users."*

The Bird-Archer Company,
90 West Street, New York.

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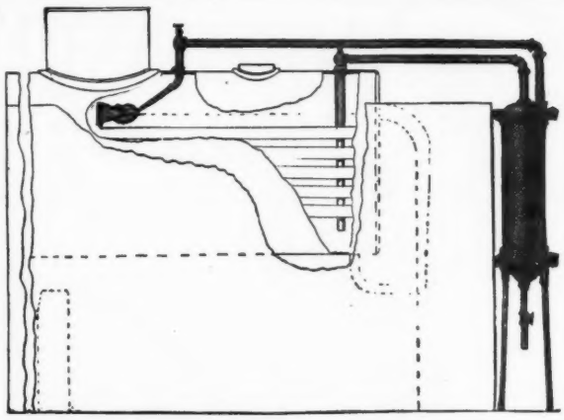
H. M. Read, 506 Fulton Bldg., Pittsburg, Pa. A. R. Shaw, 7 Water St., Boston, Mass. T. G. Oakes, 1st Nat'l Bank Bldg., Easton, Pa. Golden Rule Oil Co., 171 Washington St., Chicago, Ill. The Bird-Archer Co., 112 Market St., San Francisco, Cal. T. H. Desmond, 119 S. 4th St., Philadelphia, Pa. Maryland Elec. Rwy. & Supply Co., 510 Continental Block, Baltimore, Md. The Bird-Archer Co., 403 Cleveland Arcade, Cleveland, Ohio. Walter Bradney, Billiter Bldg., London, E. C., Eng. J. E. Luck, 22 Campbell's Wharf, Norfolk, Va. Geo. E. Chase & Co., Jacksonville, Fla. No. 4.



The Buckeye Automatic Boiler Skimmer

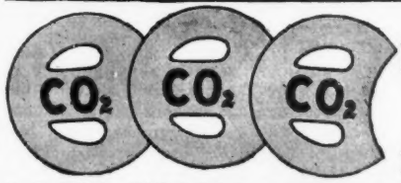
Read What One User Says

The four Skimmers recently installed in our boilers are doing all that you claimed for them. As we had troubles too numerous to mention—priming being the worst—the writer was doubtful whether the Skimmers would be able to overcome all these difficulties. However, they are making good, keep the boilers clean, save fuel and fully 90% on repairs. They are handling large quantities of clay and magnesia, and giving us clean dry steam. We consider this Skimmer a great invention and cheerfully recommend it to all steam users. Very truly yours,
(Name on application.)

BUCKEYE BOILER SKIMMER CO.
South End, Toledo, Ohio.

THE HAWK-EYE BOILER COMPOUND

NEVER FAILED.
See our Advertisement in First Issue Every Month.
HAWK-EYE COMPOUND CO.,
303-304-305 Merrick Block, CHICAGO, ILL.



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FIRE ARCHES
Any Rise, Any Span,
Air Baffle Mixing System
produces
RESULTS
C-O-TWO FURNACE COMPANY, Syracuse, N. Y.

VERY EFFICIENT.

USE OUR **STEAM BLOWER**

Patented Jan. 6, 1903. Another Patent Pending.

Manufactured only by
THE GIBSON IRON WORKS CO.,
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Stoking the Sky

helps no one but the coal dealer.

That cloud of filthy smoke over your plant is all that you get for 15% of the coal you buy.

A Wilkinson Stoker would enable you to turn it back into money. Write.

The Wilkinson Mfg. Company,
Bridgeport, Montgomery County, Pa.

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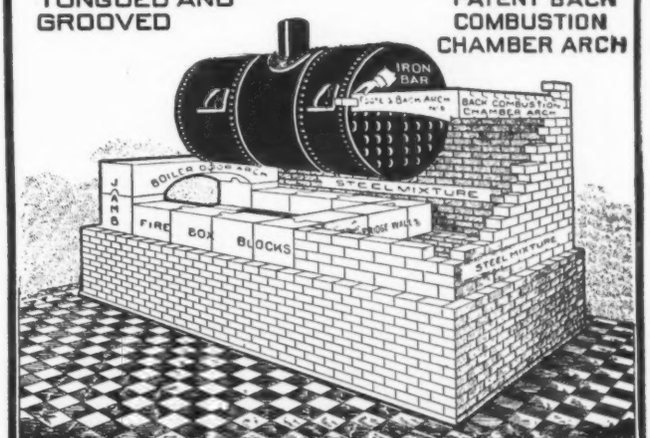
BOILER DOOR ARCHES AND FIRE BOX BLOCKS

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH



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McLEOD & HENRY CO.
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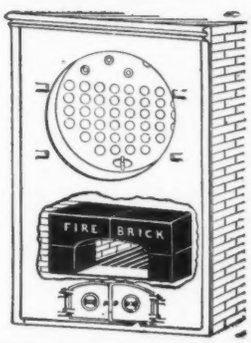
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

HEAT PROOF

The heat resistance of our fire brick is wonderful. We fit every type of boiler setting.

Write for catalog and prices.

Presbrey Fire Brick Works,
Taunton, Mass.



ANY TYPE OF BOILER

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.

UNITS OF ANY SIZE

MARTIN GRATES

Martin Anti-Friction Rocking Grates will burn slack coal and get the same steam results as ordinary grates do with best lump coal. Catalog tells why.

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PREVENT SMOKE

Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.

CLIMAX SMOKE PREVENTER COMPANY
205 Equitable Building, Boston, Mass.

GREEN TRAVELING CHAIN GRATES

AUTOMATIC SELF CLEANING SMOKELESS

GREEN ENGINEERING CO.
COMMERCIAL NATIONAL BANK BLDG., CHICAGO.
ALLIS-CHALMERS CO. CHICAGO, ILL., EXCLUSIVE AGENTS FOR ALL FOREIGN COUNTRIES EXCEPT CANADA AND MEXICO
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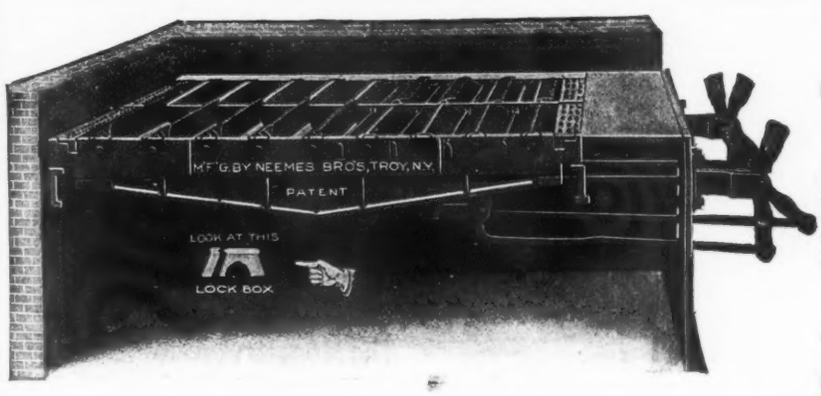

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IMPROVED

Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

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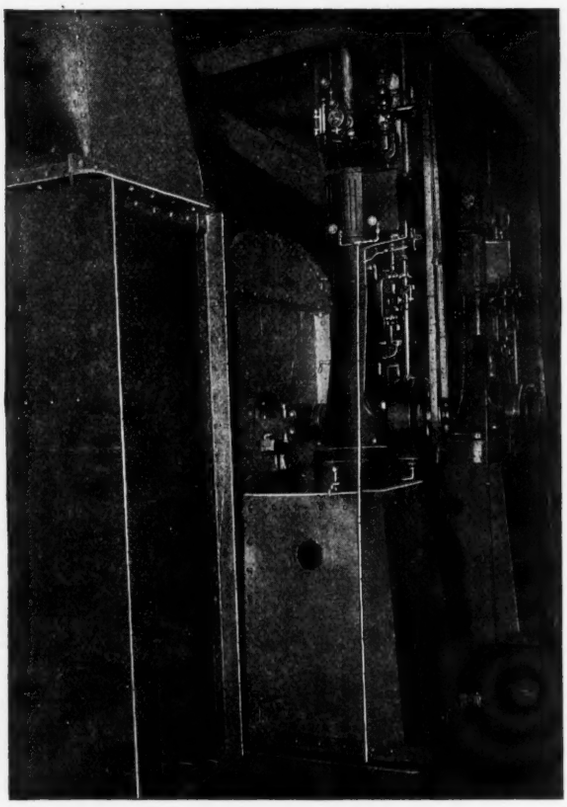


GREEN MECHANICAL DRAFT FANS for UNCLE SAM

We show above two of the three Green Induced Draft Fans and Engines installed in the Fuel Testing Laboratory of the United States Geological Survey at Jamestown. These fans were used in connection with two Heine boilers of 210 H.P. each and one B. & W. boiler of 250 H.P. The three furnaces were equipped with a Roney stoker, a Jones stoker and for hand firing respectively, and all three could be operated by natural draft, forced draft or by the Green Induced Draft Fans.

This experimental boiler plant made it possible to test the same fuel in different sizes with different methods of stoking, to vary the draft and the baffling of the gases and to determine the most economical performance with different rates of combustion. The work was so carried out that it was possible to isolate the performance of the boiler from the performance of the furnace to investigate the best methods of minimizing the smoke and to study the temperatures reached in various parts of the combustion chambers and fuel beds.

In carrying out this work, the perfect control of furnace conditions given by mechanical draft was highly important, since it made it possible to burn any fuel at almost any desired rate of combustion and with any desired excess or deficiency of air supply.

It is only by such methods that the most economical points can be determined and maintained, and this is true of commercial plants as well as test plants.

If you are going to put in new boilers, have a chimney that is too small, wish to burn cheaper grades of fuel, desire to drive the fires at a higher rate or would like to eliminate smoke or increase the efficiency of your boilers, submit a statement of your conditions to our engineers for investigation.

Ask for our Mechanical Draft Treatise, "108 P."

The Green Fuel Economizer Co.,
MATTEAWAN, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 174

"SIROCCO"

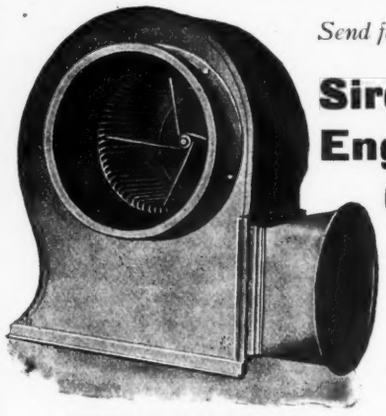
(TRADE MARK)

BLOWERS

BUILT ON THE TURBINE PRINCIPLE
SMALLEST BUT MOST POWERFUL
LIGHTEST BUT MOST EFFICIENT

FOR VENTILATING, HEATING, DRYING, COOLING, FORCED AND INDUCED DRAFT. BELT, MOTOR OR ENGINE DRIVEN. FITTED TO STEAM TURBINES.

Send for Bulletin 2002A.



Sirocco Engineering Company

138 Cedar St. New York

Works: TROY, N. Y.

Protected by 37 U. S. Patents

ENGINE AND BOILER BARGAINS

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20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
18 x 42 Hamilton Corliss	14 x 24 Atlas, Automatic
18 x 36 Wright, Corliss	13½ x 15 Taylor, Automatic
14 x 24 Wright, Corliss	12 x 18 Brownell, Automatic
12 x 24 Wetherill, Corliss	12 x 14 Green, Automatic
10 x 30 Hamilton, Corliss	12 x 12 N. Y. Safety, Automatic

Also large assortment of Automatic and Throttling Engines of other sizes.

BOILERS

84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H. P.

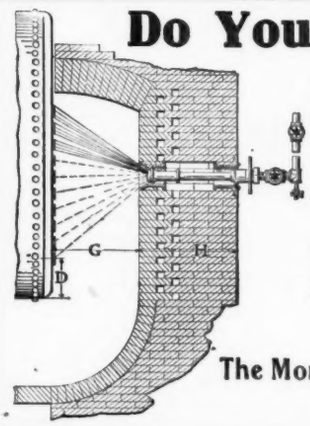
Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.

Write for bargain list.

We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

THE RANDLE MACHINERY CO.
1768 Powers St., CINCINNATI, OHIO.

Do You Appreciate

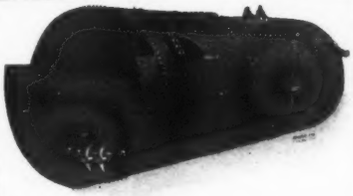


the necessity for clean boilers in the economical generation of steam? The only way to have clean boilers all the time is to use the **"Monarch Steam Flue Blower."**

It blows with the draft, not against it, thus cleaning your flues the natural way. Saves fuel. Sent on trial.

CIRCULAR?

The Monarch Steam Blower Co.
Troy, New York



KEWANEE BOILERS
Are Boilers of CHARACTER

They bear the mark of superiority. They are built by mechanics, are strong, solid, substantial, efficient, durable. Have the name KEWANEE in your specifications.

KEWANEE BOILER COMPANY
KEWANEE, ILLINOIS.

HEINE BOILERS
(Water Tube)

All flange steel construction.
Shipped from the shop completed.

BUILT ONLY BY THE
Heine Safety Boiler Co.
ST. LOUIS, MO.

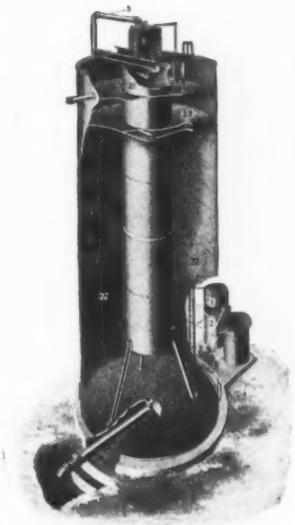
BOILER SCALE

can be prevented by softening feed water before using.

The Bartlett Water Softener

automatically accomplishes this result.

Our literature tells why.



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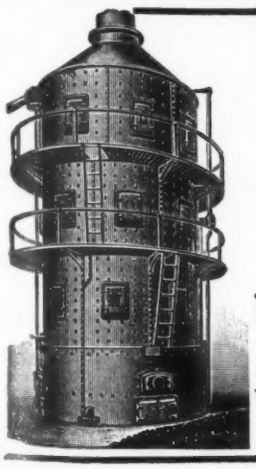

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Large heating surface, quick steam generation, fuel economy, absolute safety, strength and durability, simple construction.

You will find full details in our booklet. Write for it.

The Morrin Climax Boiler Co.
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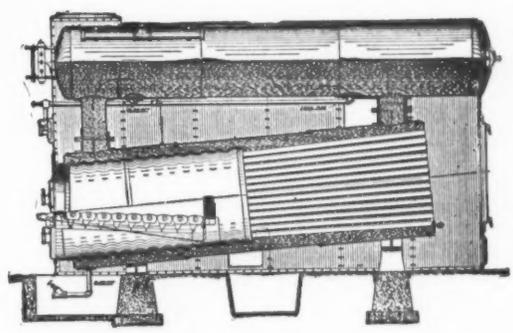
ROBB-MUMFORD

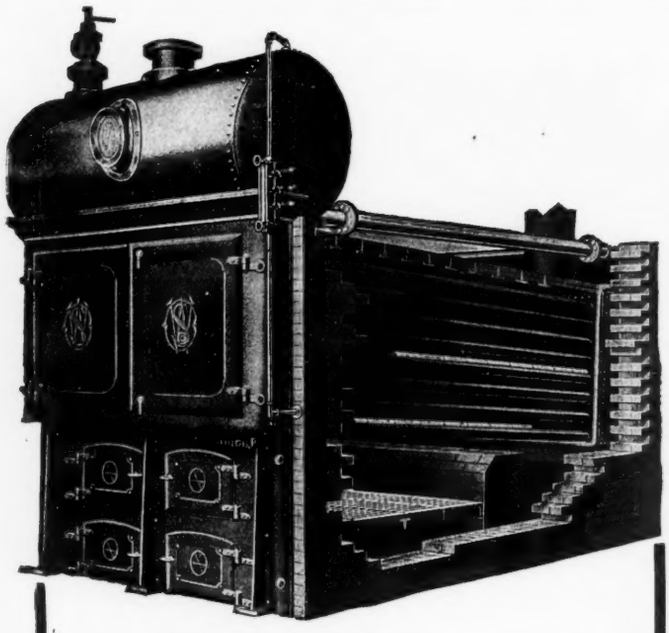


Internally Fired Boiler

Low first cost—Saving in fuel—Durable, Safe—Built in all sizes from 60 to 250 horsepower.

ROBB-MUMFORD BOILER COMPANY
SOUTH FRAMINGHAM, MASS.

New York Office. 90 West Street. Boston Office, 170 Summer Street.
Built in Canada by Robb Engineering Co., Ltd., Amherst, N. S.



The Basis Of Economy

in any power plant is the boiler system. If you appreciate that fact you will do well to investigate

Our Safety Water Tube Boiler

Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

Ask for illustrated catalog and latest test report.

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Pittsburgh, Pa.

Boiler Works Dep't., - - OSWEGO, N. Y.

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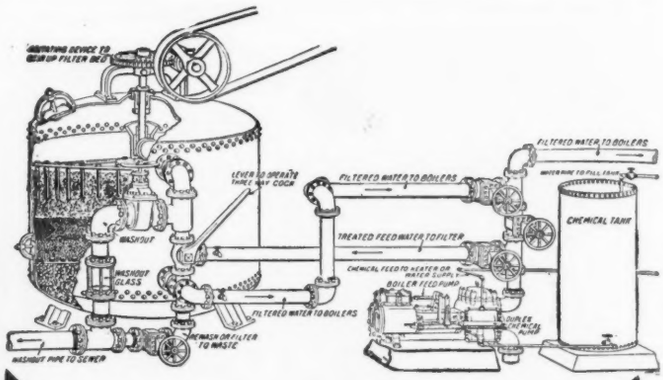


THE KEYSTONE
Pressure Filter System

is sold under this positive guarantee:

That it will remove all vegetable and mineral impurities from any water.

That boilers using feed water so treated will remain free from foaming, scale or corrosion.

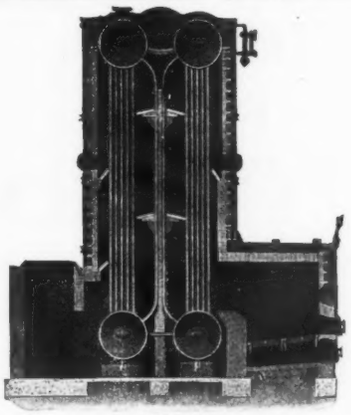
That if the KEYSTONE PRESSURE FILTER SYSTEM fails to fulfill these conditions it will be removed without cost to the customer.

OPERATION.

The diagram above shows a complete installation. Observe its compactness, and the absence of settling tanks or other cumbersome accessories. Its operation is absolutely positive. Nothing is left to chance. The water to be purified is subjected to careful chemical analysis; its dissolved impurities determined and a chemical agent provided that will precipitate itself and the dissolved impurities together, as insoluble matter. In this form it is filtered out together with the suspended impurities, leaving a pure, harmless water to enter the boilers.

Complete information supplied on request.

The Keystone Chemical Mfg. Co.
Philadelphia Chicago San Francisco



TYPE B

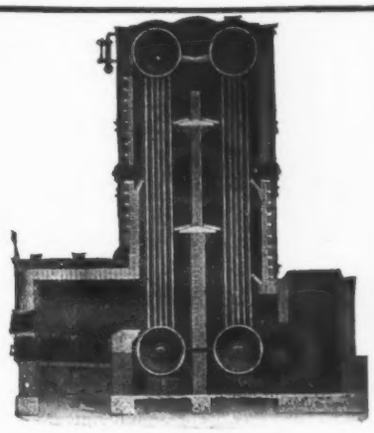
THE RUST
WATER TUBE
BOILER

SAFE, SIMPLE, DURABLE,
ECONOMICAL, ACCESSIBLE

Write for Report of Tests by William Kent.

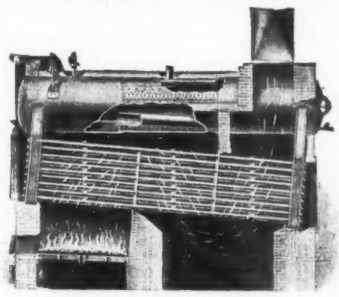
THE RUST BOILER CO.,
PITTSBURGH, PENNA.

THE RUST ENGINEERING CO., Southern Agents { Birmingham, Ala. New Orleans, La.



TYPE C

Water Tube Boilers



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ESTABLISHED 1865.

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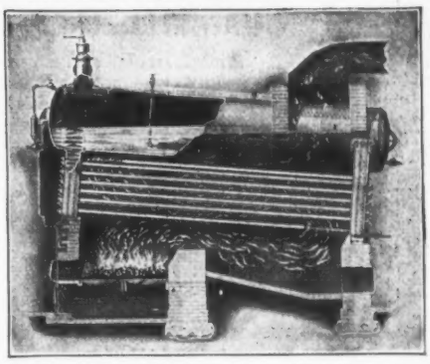
New York, Philadelphia, Chicago, San Francisco, Wilkesbarre and New Orleans.

FRANKLIN WATER TUBE BOILER



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FRANKLIN BOILER WORKS CO.,
TROY, N.Y.

SALES OFFICE
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New York, N. Y.

PARKER BOILER CO.

WATER TUBE BOILERS—SUPERHEATERS.

PHILADELPHIA, PENNA.

New York—Pittsburg—Chicago—Denver—San Francisco.

Foster Superheaters

Save feed water, condensing water, coal and boiler power.

POWER SPECIALTY CO.,
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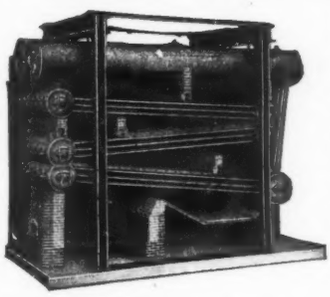

in every part. Vogt Water Tube Boilers are guaranteed to show the most rapid circulation and the most economical steam making efficiency of any boilers made.

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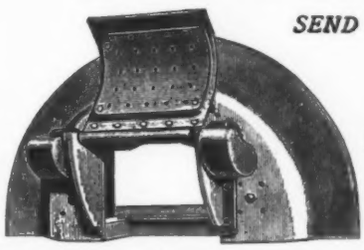
MORRISON

Protector Fire Fronts & Doors

For Land and Marine Boilers



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Near 10th and 23d Ferries
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—WATER TUBE—

EDGE MOOR IRON CO., Edge Moor, Delaware

Results of 27 years' Boiler Making Experience

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THE BABCOCK & WILCOX COMPANY

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WATER TUBE STEAM BOILERS

STEAM SUPERHEATERS—MECHANICAL STOKERS

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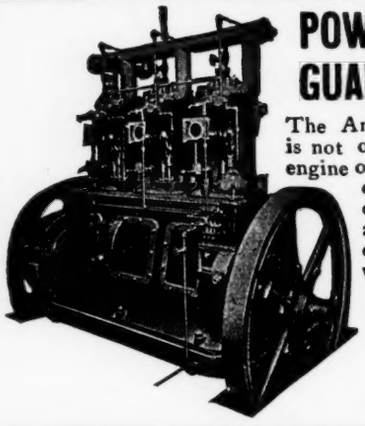

POWER COSTS GUARANTEED

The American Diesel Engine is not only the most efficient engine on earth but it burns the cheapest liquid fuel—crude oil. We can guarantee a cost which no other engine can develop under test.

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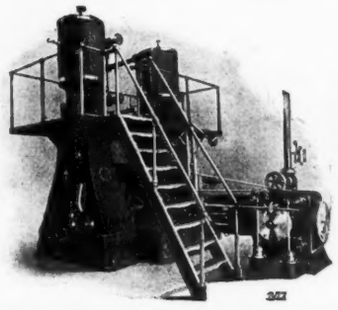
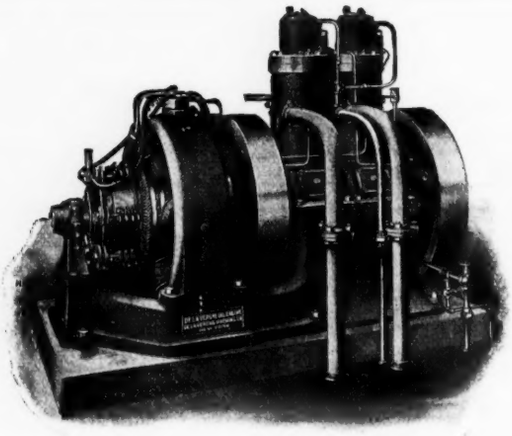


We manufacture all machinery and parts needed to equip a com lete Ice or Refrigerating plant—

Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings.

of all kinds. We employ over 1,250 men in the manufacture of Ice and Refrigerating Machinery exclusively. Catalogue sent upon request.



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OIL ENGINES

are cheaper, simpler, more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

5315 H. P. used by Baldwin Locomotive Works

The "De La Vergne" Vertical two-Cycle 4 to 25 H. P.
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Foot East 138th Street, NEW YORK.

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Satisfaction:—

That absolute knowledge that your ice machine is producing full capacity at the minimum expense; that there is no danger of shut downs for repairs—this is the result of using Triumph machinery.

The Palmyra Ice Co., Palmyra, Mo., state—"The machine is a light steam user and the construction is such as to guarantee long life with light repair bills. In fact, our repair bills during the past season have been nothing and the machine has been used constantly all summer night and day up to Dec. 1st. Were we in need of another machine, we would duplicate it."

In addition to our unequaled compressor construction, remember we also provide you

"The fittings that don't leak."

Let us send you catalog "Triumph Originality."

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We'll work out your Oil and Gas Engine Designs, in part or whole. We're ready to act in the capacity of **consulting engineers.** Our charges will probably be lower than **you** could do the work for yourself. Let's get in touch through the mails.

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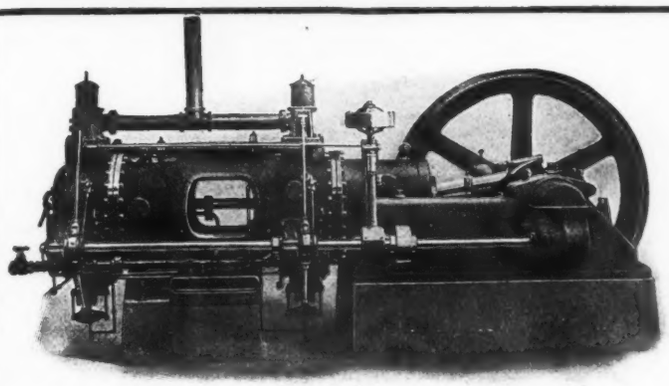

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Horizontal and Vertical Types up to 700 H. P.

NOT AN EXPERIMENT

Economy and Reliability Have Been Demonstrated by Actual Service

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For All Street Railway, Electric Light and Power Requirements

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AN ECONOMICAL AND DURABLE ROTARY ENGINE
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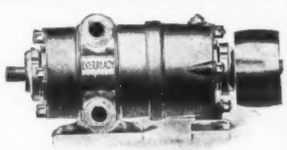

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ALBERGER TANDEM GAS ENGINES
ACCURATE REGULATION FOR ELECTRIC SERVICE-AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR
A.H.ALBERGER COMPANY
45 TO 600 H.P. USING NATURAL GAS
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As Low As 3c. A H.P. For Ten Hours

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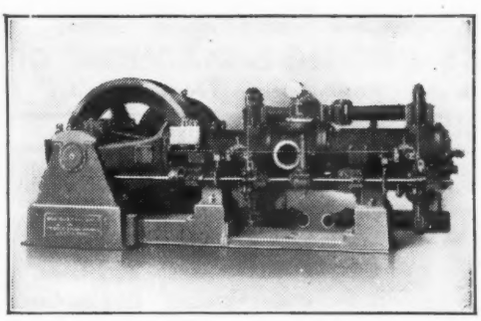

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Simplicity of design, splendid construction, absolute governor control, fuel economy and sufficient weight to withstand the continuous high pressure of explosions to which they are subjected. *Write for Catalog "G."*

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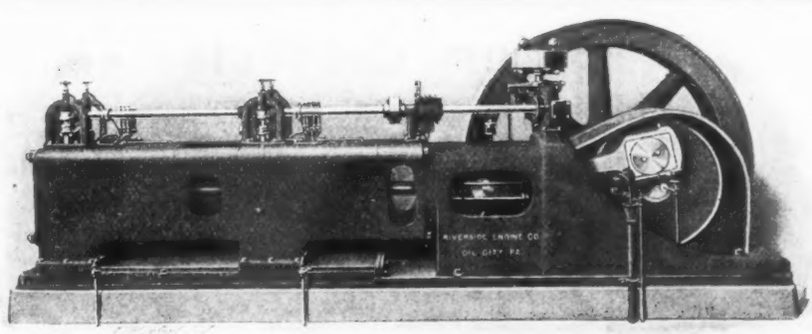
ESTABLISHED 1877.
805 Brady Street, Du Bois, Pennsylvania.



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Engines are the standard American Gas Engine. They have the reliability of a steam engine, the greatest accessibility, are extremely simple and are economical to operate.

Built in all types, single cylinder, single acting to twin tandem double acting, 40 to 2,500 H. P.

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Riverside Heavy Duty Single Acting Tandem Gas Engine (Class C)

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the use of which insures a high economy in steam consumption and a minimum cost of maintenance.

The design is unsurpassed for simplicity and compactness, while the details of valves and gear, bed-plate construction, etc., are greatly liked by all users.

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MAKE YOUR OWN LIGHT Why not?

Capacity: 30 to 500 Lights

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Figure out your present cost of lighting, then let us show you how to reduce the expense and at the same time have better light, better distribution, and more satisfactory service in every way. Needs the least amount of steam, space and attention and will out wear anything of its kind on the market.

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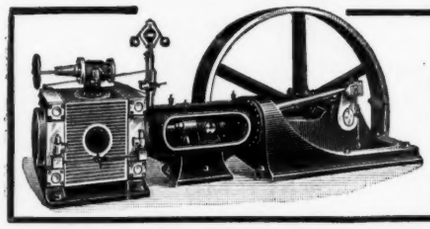

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always reliable. The quality and workmanship never varies, except as it changes gradually and consistently for the better. Never freakish—just a common sense adherence to all that's good. Catalog?

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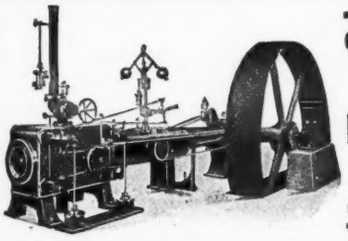

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Refrigerating and Ice Making Machinery

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Built only by

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Engines have been tried and found true—let us tell you more about them.

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MOUND TOOLS. FOR THE ENGINE ROOM.

This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.

No. 20 Set of 20 Tools . . . $4.00.

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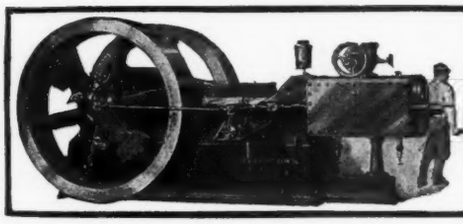

Good Engines for every power purpose. Ask for Catalog.

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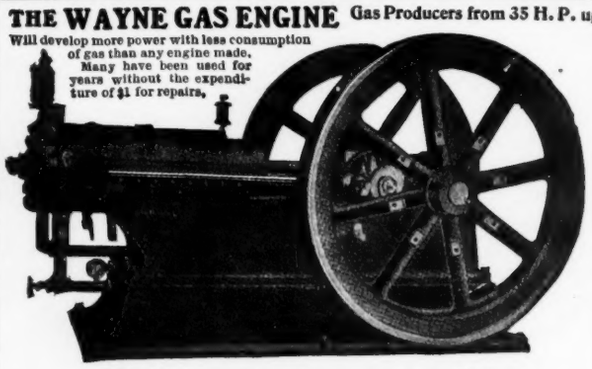
THE WAYNE GAS ENGINE Gas Producers from 35 H. P. up.

Will develop more power with less consumption of gas than any engine made. Many have been used for years without the expenditure of $1 for repairs.



Each engine covered by a positive guarantee. Send for Catalog

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For Electric Work

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Providence Suction Producer and Gas Engine

Providence Steam Turbo Generator

Successful operation at lowest cost assured. Our catalog gives details. Write.

PROVIDENCE ENGINEERING WORKS,

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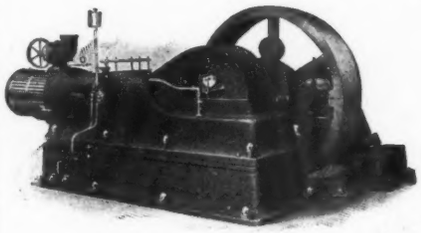
Skinner Engines



SIDE CRANK TYPE

CENTER CRANK
SIDE CRANK
SINGLE and FOUR VALVE

Skinner Engine Co.,
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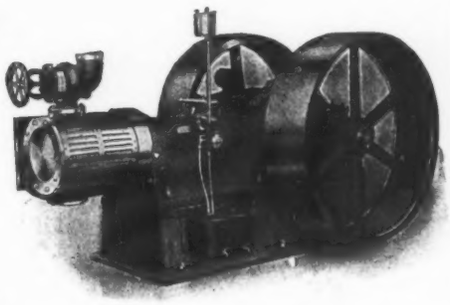

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If A Belt Breaks

the Automatic Safety Stop of the

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closes the valve instantly by removing the support of the speed lever fulcrum.

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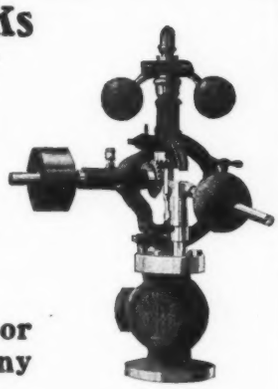
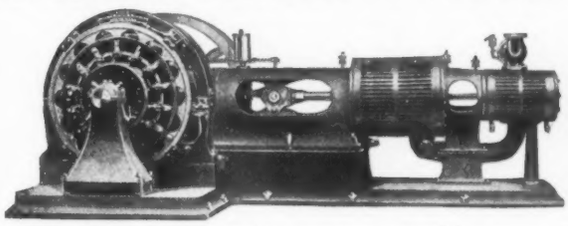


The Gardner Governor & Separator Company
Quincy, Illinois.

No Need To Go Home In The Dark



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RIDGWAY, PA., U. S. A.

The overload capacity of **C-W** electric generators makes them popular with the engineer. In emergencies they do better than is expected of them. Bulletin 80M describes our D. C. machines.

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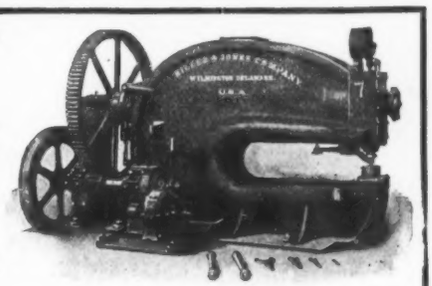
The Motor

FOR DRIVING HEAVY TOOLS

C & C

Type "S L"
Variable Speed

The connection is made by gearing and the motor is especially wound for the severe work required of it.



For every industrial use a C. & C. MOTOR is a wise choice.

The C & C Electric Co.

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Agencies in all principal cities.

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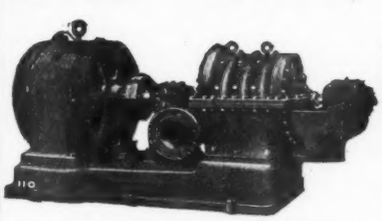

Steam Turbine Motors
Steam Turbine Dynamos
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Works and Sales Offices, TRENTON, N. J.

NORTHERN TRANSMISSION SYSTEMS FIT OLD PLANTS AS WELL AS NEW

The use of our product assures convenient, speedy, economical production. Our generators are readily installed in connection with old power plants. Our motors are easily applied to all classes of machine drives. If you want us to discuss your requirements for electrical machinery, say what you plan doing electrically. Tell us at once so that our propositions and suitable literature may be in your hands for early consideration. Send for bulletin 850.

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STANDARD AND SPECIAL ELECTRICAL MACHINERY.

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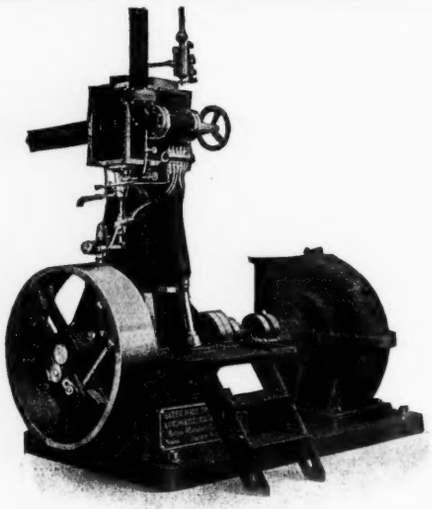

Bates Vertical Automatic High Speed Engine for connection to Pumps. Especially adapted for

WATER WORKS, IRRIGATION

and other places where it is desired to move a large volume of water at small expense.

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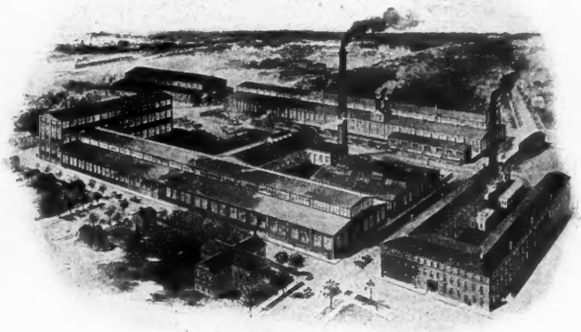

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HIGH EFFICIENCY
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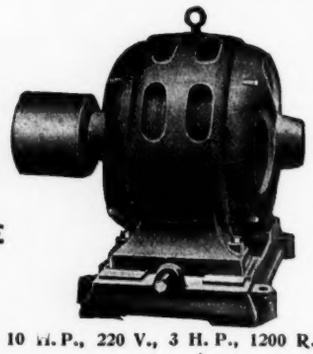

1 TO 75 H. P.

10 H. P., 220 V., 3 H. P., 1200 R. P. M.

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BRANCHES IN ALL LARGE CITIES

FORT WAYNE ELECTRIC WORKS
WOOD SYSTEMS

Lamps or Motors

or both, it makes no difference what kind of a load you have on Type A transformers—even an overload—they still give best service.

15 K.W. Type A Transformer

Do You Know

that standard Type A transformers meet every requirement with better regulation, better service and lower operating cost.

Bulletin 1096 describes Type A Transformers

ASK FOR IT. 701

SALES OFFICES — Main Office: FORT WAYNE, IND. — IN MOST LARGE CITIES

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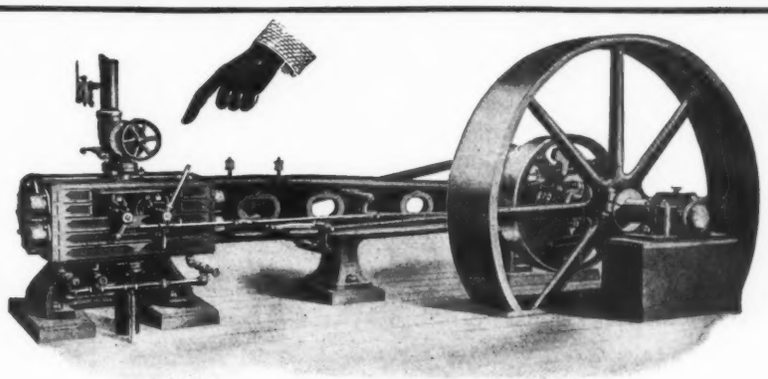
CORLISS ENGINES

BERRY SAFETY **BOILERS** POWER PLANTS

The Famous Fitchburg Engine



Gives the engineer less trouble and the owner less cost than any other ever built. Ask for a catalog.

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FITCHBURG, MASS.

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BUCKEYE ENGINE COMPANY,

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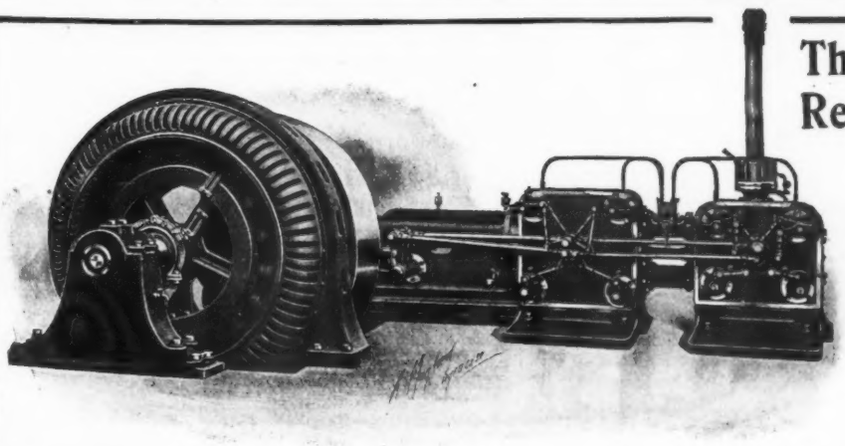
BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION
AND
ABSOLUTELY RELIABLE

CORRESPOND WITH US BEFORE PURCHASING

CATALOGS ON APPLICATION



This Engine Runs 200 Revolutions per Minute

High speeds; high pressures; unsurpassed economy; low repairs; the most perfect valve motion; low cost per engine horse power; still lower generator cost. The first Corliss engine we ever built run 26 years at the rate of 11 hours per day. It is still absolutely perfect and is the engine we show prospective buyers. Better investigate our engine records.

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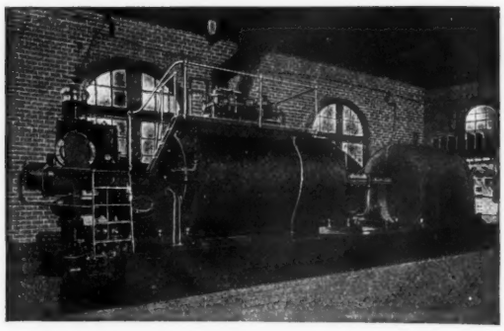
CLARK BROS. CO.
Belmont, N. Y.

Water Conditions

often make it impracticable to use condensing engines, in such cases the good results of the latest



Westinghouse Non-Condensing Steam Turbine

make it superior, in many instances, to other types of non-condensing steam engines:—

If suitable cooling water is lacking in your locality, state your conditions to our nearest sales office and they will explain the advantages in the use of Westinghouse Non-Condensing Turbines. They are especially adapted to power and heating plants.

The Westinghouse Machine Company,

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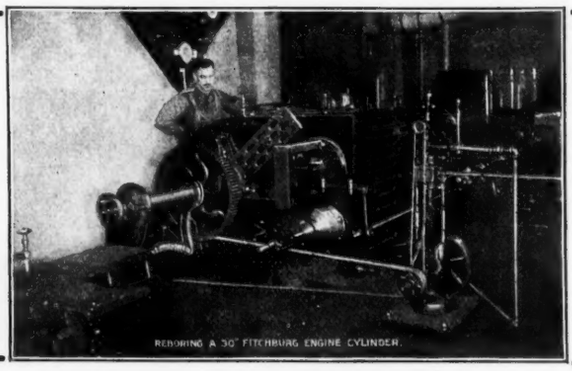
If You Can't Afford A Long Delay



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We are the quick repair people who rebore cylinders and make other repairs 'twixt sunset and sunrise without dismantling the engine. Our charges are reasonable.

Ammonia Cylinders Indicated.

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ESTABLISHED 1870
1021 Hamilton St., Philadelphia, Pa.

YOURS
ON A MINUTE'S NOTICE

We have for immediate delivery:

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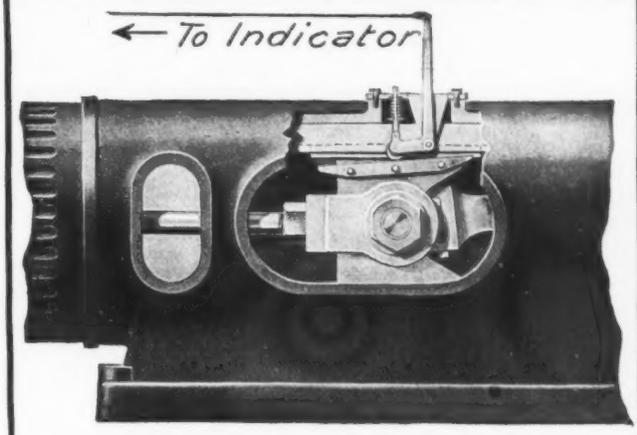

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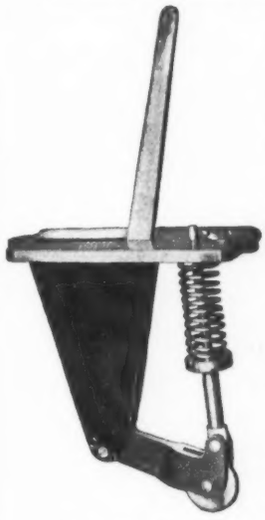

This device gives a theoretically correct motion, is self contained and is always ready and in place. You don't have to hook any swing lever to the roof or erect a temporary structure to support a pantograph lazy tongs or other mechanism.

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AMERICAN BALL ENGINES represent 30 years of progressive developements.

Write for Bulletin No. 14.

AMERICAN ENGINE CO.

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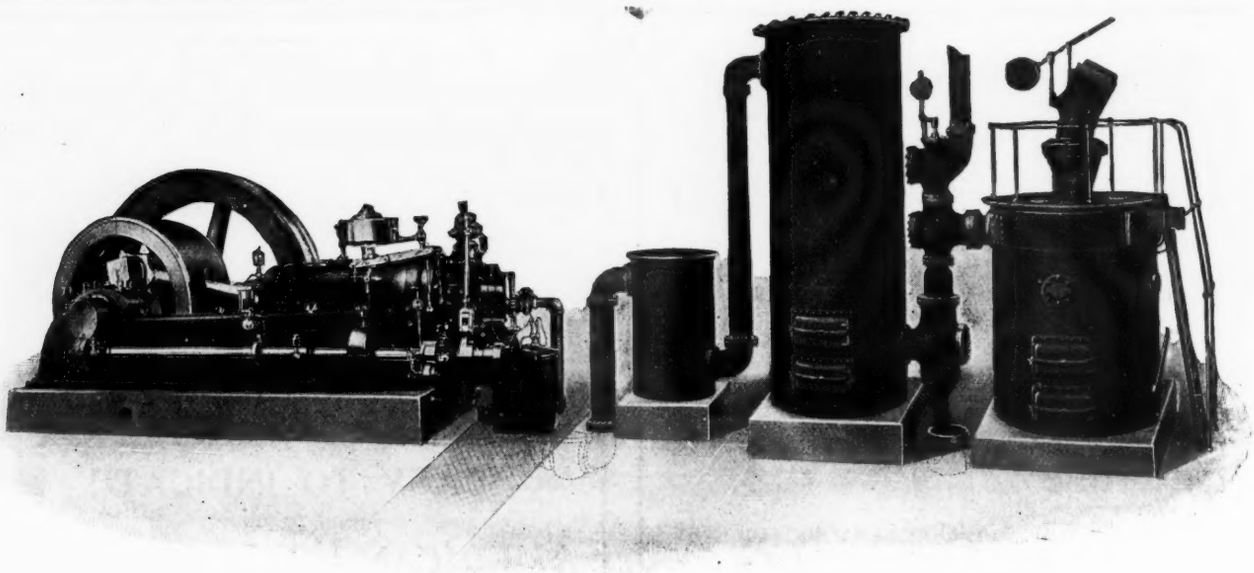

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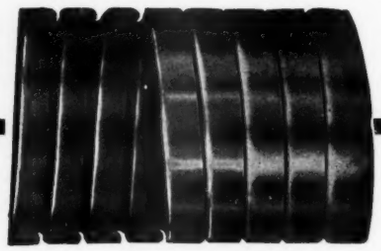

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